

<b>AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT</b>				1. CONTRACT ID CODE N/A		PAGE 1 OF 128 PAGES	
2. AMENDMENT/MODIFICATION NO. 0001		3. EFFECTIVE DATE JAN. 28, 2005		4. REQUISITION/PURCHASE REQ. NO. N/A		5. PROJECT NO. (If applicable) SPEC. NO. 1329	
6. ISSUED BY CODE				7. ADMINISTERED BY (If other than Item 6) CODE			
LOS ANGELES DISTRICT , COE CESPL-CT-WEST REGION BRANCH P.O. BOX 532711 LOS ANGELES, CALIFORNIA 90053-2325				LOS ANGELES DISTRICT , COE CESPL-CT-WEST REGION BRANCH P.O. BOX 532711 LOS ANGELES, CALIFORNIA 90053-2325			
8. NAME AND ADDRESS OF CONTRACTOR (No., street, county, State and ZIP Code)				(✓)		9A. AMENDMENT OF SOLICITATION NO. W912PL-05-R-0006	
				✗		9B. DATED (SEE ITEM 11) JANUARY 12, 2005	
						10A. MODIFICATION OF CONTRACTS/ORDER NO. N/A	
						10B. DATED (SEE ITEM 13) N/A	
CODE		FACILITY CODE					

**11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS**

☒ The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended, ☒ is not extended.

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods:

(a) By completing Items 8 and 15, and returning 1 copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA (If required)

N/A

NOTE: ITEM 13 BELOW IS N/A.

**13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS, IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.**

(✓)	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A. N/A
	B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).
	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:
	D. OTHER (Specify type of modification and authority) N/A

**E. IMPORTANT:** Contractor ☐ is not, ☐ is required to sign this document and return \_\_\_\_\_ copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)

Command and Control Facility  
Ft. Irwin, CA

2 Encl.

1. Revised Pages: Table of Contents, Pricing Schedule, 00800-3, Attachment No. 1 (Replace existing in its entirety), Amendment No. 7(New), Section 01335(New), 04200-13, 04200-21, 07548-4, 10800-4, 13080-7, Section 15951 (Replace existing in its entirety)
2. Revised Drawings: G30, G31, S001, S102, S106, S511, S513, S517 , DELETE Sheet C131in its entirety

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER (Type or print)		16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print)	
15B. CONTRACTOR/OFFEROR  (Signature of person authorized to sign)		16B. UNITED STATES OF AMERICA BY (Signature of Contracting Officer)	
15C. DATE SIGNED		16C. DATE SIGNED	

**COMMAND AND CONTROL FACILITY  
FT. IRWIN, CA.**

**TABLE OF CONTENTS  
VOLUME 1 of 2**

001	Cover Sheet
002	Security Requirements
003	Table of Contents
004	SF 1442
005	Pricing Schedule
006	Section 00100
007	Section 00110
008	Section 00120
009	Section 00600
010	Section 00700
011	Section 00800

012 ATTACHMENTS:

1	General Wage Decision
2	PreAward Data
3	Subcontracting Plan
4	Contractor Prepared As-Builts
5	Drawing List
6	MILCON Project Closeout (Red Zone Meeting)
<b>7</b>	<b><i>Sustainable Project Rating Tool</i></b>

013 TECHNICAL SPECIFICATIONS

DIVISION 01-GENERAL

01312	Quality Control System (QCS)
01320	Project Schedule
01330	Submittal Procedures
<b>01335</b>	<b><i>Sustainable Design and Development</i></b>
01355	Environment Protection
01420	Sources for Reference Publications
01451	Contractor Quality Control
01500	Temporary Construction Facilities
01505	General Requirements
01572	Construction and Demolition Waste Management
01670	Recycled/Recovered Materials
01780	Closeout Submittals
01781	Operation and Maintenance Data

## CERTIFICATE OF CORPORATE PRINCIPAL

1) IF THE OFFEROR IS A JOINT VENTURE, COMPLETE THE FOLLOWING:

_____	_____	_____
(Company Name)	(Signature)	(Title)

_____	_____	_____
(Company Name)	(Signature)	(Title)

_____	_____	_____
(Company Name)	(Signature)	(Title)

2) IF THE OFFEROR IS PARTNERSHIP, LIST FULL NAME OF ALL PARTNERS:

_____	_____	_____
(Company Name)	(Signature)	(Title)

_____	_____	_____
(Company Name)	(Signature)	(Title)

_____	_____	_____
(Company Name)	(Signature)	(Title)

3) IF THE OFFEROR IS A CORPORATION, THE FOLLOWING CERTIFICATION SHOULD BE COMPLETED:

## CERTIFICATION AS TO CORPORATE PRINCIPAL

I, \_\_\_\_\_, certify that I am the Secretary of the corporation named as principal in the

within contract; that \_\_\_\_\_, who signed the said contract on behalf of the principal, was the

\_\_\_\_\_ of the corporation; that I know his signature and that his signature is genuine; and that said contract was duly signed, sealed and attested for in behalf of said corporation by authority of its governing body.

\_\_\_\_\_  
CORPORATE PRINCIPAL

CORPORATE SEAL

SECRETARY

**SECTION 00010 PRICING SCHEDULE**

The Contractor shall furnish all plant, labor, material, equipment, etc., necessary to perform all work in strict accordance with the terms and conditions set forth in the contract to include all attachments thereto:

**BASE BID**

Line Item No.	Description	Quantity	Unit of Measure	Unit Price	Total Price
0001	Construct Command and Control Building to the 2 Meter Building Line, Complete. (Except as noted below)	1	Job	Lump Sum	\$
0002	Site Work, Utilities and Infrastructure Outside the 2 Meter Building Line, Complete	1	Job	Lump Sum	\$

**TOTAL BASE BID** \$ \_\_\_\_\_  
**(Line Items 0001-0002)**

**OPTIONS**

0003	<b>(Option #1)</b> Generator and Fuel tank (Provide concrete pads and conduits necessary for hoop-up, including enclosed equipment yard as designed) Complete	1	Job	Lump Sum	\$
0004	<b>(Option #2)</b> CAT VI Cabling, Complete	1	Job	Lump Sum	\$
0005	<b>(Option #3)</b> Parking/Landscaping/Electrical, including all the associated Landscaping and electrical, Complete	1	Job	Lump Sum	\$
0006	<b>(Option #4)</b> Lighting Fixtures Complete	1	Job	Lump Sum	\$
0007	<b>(Option #5)</b> 92 Lights, Complete	1	Job	Lump Sum	\$
0008	<b>(Option #6)</b> Conference Rooms' Verticality Folding Acoustical Wall (Option will include folding walls, the Government will install the walls with other funds if not purchased in this contract, so the structural beams must still be provided to insure this may be done at a later time)	1	Job	Lump Sum	\$

0009	<b>(Option #7)</b> Courtyard Ductwork (this is additional ductwork and louvers that allow return-air from the Break Room to be dumped into the courtyard to help create a micro-climate) Complete	1	Job	Lump Sum	\$
0010	<b>(Option #8)</b> Mini-TOC Nodes (seven TOC Nodes located within the security fenced area directly behind the facility) Complete	1	Job	Lump Sum	\$
<del>0011</del>	<del><b>(Option #9)</b> Demo Bldgs<sup>2</sup> 373 &amp; 950, Complete</del> NOT USED	<del>1</del>	<del>Job</del>	<del>Lump Sum</del>	<del>\$</del>
0012	<b>(Option #10)</b> Uninterruptible Power Supply (UPS)	1	Job	Lump Sum	\$
<b>TOTAL OPTION ITEMS: \$ _____</b>					
<b>(Line Items 0003-0012)</b>					
<b>TOTAL AMOUNT \$ _____</b>					
<b>BASE BID&amp; OPTIONS (Line Items 0001-0012)</b>					

1. Prices must be submitted on all individual items in this Pricing Schedule. Failure to do so may cause for rejection of the bid/offer.
2. If a modification to a price is submitted which provides for lump sum adjustments to the total price, the application of the lump sum adjustment to each item in the Pricing Schedule must be stated. If it is not stated, the bidder/offeror agrees that the lump sum adjustment shall be applied on a pro rata basis to every item in the Pricing Schedule.
3. The bidder/offeror shall distribute his indirect costs (overhead, profit, bond, etc.) over all the items in the Pricing Schedule. The Government will review all submitted Pricing Schedules for any unbalancing of the items. Any submitted Pricing Schedule determined to be unbalanced may be considered nonresponsive and cause the bidder/offeror to be ineligible for award.
4. The lump sum, "LS", line items above are not "estimated quantity" line items and therefore are not subject to the "Variation in Quantity" contract clause.
5. The successful bidder/offeror grants the Options listed in the Pricing Schedule to the Government. These Options may be exercised any time up to **(365)** calendar days after receipt of Notice to Proceed. Exercise of the option (s) occurs upon mailing of written notice to the Contractor. Exercise will be made by the Contracting Officer. The price for exercise of the Option(s) includes all work and effort associated with the scope of that item. For determination of lowest bid/offer, refer to paragraph titled "EVALUATION OF OPTIONS" in Section 00100 of this solicitation. No additional time for contract completion will be allowed when an Option is exercised. The given contract completion time was formulated to include time necessary to perform all option work.
6. EFARS 52.214-5000 ARITHMETIC DISCRPANCIES
  - (a) For the purpose of initial evaluation of bids/offers, the following will be utilized in resolving arithmetic discrepancies found on the face of the Pricing Schedule as submitted by bidders/offerors:
    - (1) Obviously misplaced decimal points will be corrected;
    - (2) Discrepancy between unit price and extended price, the unit price will govern;
    - (3) Apparent errors in extension of unit prices will be corrected;
    - (4) Apparent errors in addition of lump sum and extended prices will be corrected.
  - (b) For the purpose of bid/offer evaluation, the Government will proceed on the assumption that the bidder/offeror intends the bid/offer to be evaluated on basis of the unit prices, the totals arrived at by resolution of arithmetic discrepancies as provided above and the bid/offer will be so reflected on the abstract of the bids/offers.
  - (c) These correction procedures shall not be used to resolve any ambiguity concerning which bid/offer is low.
7. Availability of Funds, FAR 52.232-18: "Funds are not presently available for this contract. The Government's obligation under this contract is contingent upon availability of appropriated funds for which payment for contract purposes can be made. No legal liability on the part of the Government for any payment may arise until funds are made available to the Contracting Officer for this contract and until the Contractor receives notice of such availability, to be confirmed in writing by the Contracting Officer."
8. The Contract Clause 52.232-27, "Prompt Payment for Construction Contracts" requires that the name and address of the contractor official, to whom payment is to be sent, be the same as that in the contract or in a proper Notice of Assignment.
9. Principal Contracting Officer. The Contracting Officer who signs this contract will be the Principal Contracting Officer for this contract. However, any Contracting Officer assigned to the

Los Angeles District, contracting within his authority, may take formal action on this contract when the Principal Contracting Officer is unavailable and the action needs to be taken.

10. Payment of Electronic Funds Transfer (EFT) is the mandatory method of payment. The Contractors attention is directed to Contract Clause No. 52.232-33 "Payment by Electronic Funds Transfer-Central Contractor Registration," located in Section 00700.
11. When applicable, the Price Evaluation Preference for HUBZone Small Business Concerns will be applied to this procurement. The bidders attention is direct to Section 00600, Contract Clause No. 52.219-4, entitled, "Price Evaluation Preference for HUBZone Small Business Concerns." The Price Evaluation Preference for Small Disadvantaged Business will not be applied to this procurement as it is currently suspended from DoD.
12. Partnering. In order to accomplish this contract, the Government is encouraging the formation of a cohesive partnership with the contractor and its subcontractors. This partnership would strive to draw on the strengths of each organization in an effort to achieve a quality product done right the first time, within budget, and on schedule. This partnership would be bilateral in make-up and participation would be totally voluntary. Any costs associated with effectuating this partnership will be agreed to by both parties and will be shared equally with no change in contract price.

Prior to the commencement of work hereunder, the Contractor shall furnish to the Contracting Office a certificate or written statement of the above required insurance. The policies evidencing required insurance shall contain an endorsement to the effect that cancellation or any material change in the policies adversely affecting the interests of the Government in such insurance shall not be effective until 10 days after written notice thereof to the Contracting Officer.

The Contractor agrees to insert the substance of this clause, including this paragraph, in all subcontracts

#### 52.211-10 COMMENCEMENT, PROSECUTION, AND COMPLETION OF WORK (APR 1984)

The Contractor shall be required to (a) commence work under this contract within 10 (Ten) calendar days after the date the Contractor receives the notice to proceed, (b) prosecute the work diligently, and (c) complete the entire work ready for use not later than 540 calendar days after receipt of Notice to Proceed. The successful contractor grants the Options listed in the Pricing Schedule to the Government. These Options may be exercised at any time up to 365 calendar days after receipt of Notice to Proceed. The price for exercise of the Option(s) includes all work and effort associated with the scope of that item. No additional time for contract completion will be allowed when an Option is exercised. The given contract completion time was formulated to include time necessary to perform all option work. The time stated for completion shall include final cleanup of the premises.

(End of clause)

#### 52.211-12 LIQUIDATED DAMAGES--CONSTRUCTION (SEP 2000)

(a) If the Contractor fails to complete the work within the time specified in the contract, the Contractor shall pay liquidated damages to the Government in the amount of \$650.00 for each calendar day of delay until the work is completed or accepted.

(b) If the Government terminates the Contractor's right to proceed, liquidated damages will continue to accrue until the work is completed. These liquidated damages are in addition to excess costs of repurchase under the Termination clause.

(End of clause)

#### 52.211-13 TIME EXTENSIONS (SEP 2000)

Time extensions for contract changes will depend upon the extent, if any, by which the changes cause delay in the completion of the various elements of construction. The change order granting the time extension may provide that the contract completion date will be extended only for those specific elements related to the changed work and that the remaining contract completion dates for all other portions of the work will not be altered. The change order also may provide an equitable readjustment of liquidated damages under the new completion schedule.

(End of clause)

#### 52.231-5000 EQUIPMENT OWNERSHIP AND OPERATING EXPENSE SCHEDULE MAR 1995)—EFARS

(a) This clause does not apply to terminations. See 52.249-5000, Basis for Settlement of Proposals and FAR Part 49.

(b) Allowable cost for construction and marine plant and equipment in sound workable condition owned or controlled and furnished by a contractor or subcontractor at any tier shall be based on actual cost data for each piece of equipment or groups of similar serial and series for which the Government can determine both ownership and

GENERAL DECISION: CA20030037 01/14/2005 CA37

Date: January 14, 2005

General Decision Number: CA20030037 01/14/2005

Superseded General Decision Number: CA020037

State: California

Construction Types: Building, Heavy (Heavy, and Dredging) and Highway

County: San Bernardino County in California.

BUILDING CONSTRUCTION PROJECTS; DREDGING PROJECTS (does not include hopper dredge work); HEAVY CONSTRUCTION PROJECTS (does not include water well drilling); HIGHWAY CONSTRUCTION PROJECTS

Modification Number	Publication Date
0	06/13/2003
1	01/30/2004
2	03/05/2004
3	04/02/2004
4	05/21/2004
5	07/02/2004
6	07/16/2004
7	08/27/2004
8	10/08/2004
9	10/22/2004
10	01/14/2005

\* ASBE0005-002 08/01/2004

	Rates	Fringes
Asbestos Workers/Insulator (Includes the application of all insulating materials, protective coverings, coatings, and finishes to all types of mechanical systems)...	\$ 34.06	9.84

\* ASBE0005-004 01/01/2004

	Rates	Fringes
Asbestos Removal worker/hazardous material handler (Includes preparation, wetting, stripping, removal, scrapping, vacuuming, bagging and disposing of all insulation materials from mechanical systems, whether they contain asbestos or not)...	\$ 15.75	2.55

BOIL0092-003 01/01/2004

	Rates	Fringes
Boilermaker.....	\$ 32.84	15.61

BRCA0004-011 05/01/2004

	Rates	Fringes
Bricklayer Bricklayer; Marble Mason....	\$ 29.67	7.45

BRCA0018-006 09/01/2004

	Rates	Fringes
Marble Finisher.....	\$ 20.70	5.81
Tile Finisher.....	\$ 17.25	4.16
Tile Layer.....	\$ 27.50	9.37

BRCA0018-010 09/01/2004

	Rates	Fringes
Terrazzo Finisher.....	\$ 21.89	7.76
Terrazzo Worker.....	\$ 29.13	7.76

CARP0409-002 07/01/2003

	Rates	Fringes
Diver		
(1) Wet.....	\$ 526.88	7.38
(2) Standby.....	\$ 263.44	7.38
(3) Tender.....	\$ 255.44	7.38
Standby.....	\$ 263.44	7.38
Wet.....	\$ 526.88	7.38

NOTE: Amounts in "Rates" column are per day

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CARP0409-008 07/01/2003

	Rates	Fringes
Modular Furniture Installer		
(1) Mobile Filing System Installer.....	\$ 13.76	5.80
(2) Modular Furniture Installer.....	\$ 14.36	5.80
(3) Full Wall Technician....	\$ 20.47	5.80
Full Wall Technician.....	\$ 20.47	5.80
Mobile Filing System Installer.....	\$ 13.76	5.80
Modular Furniture Installer.	\$ 14.36	5.80

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ELEC0477-002 05/31/2004

	Rates	Fringes
Electricians:		
Cable splicer.....	\$ 30.15	3%+13.00
Electrician,Tunnel Work.....	\$ 32.07	3%+13.00
Electrician.....	\$ 29.15	3%+13.00

CABLE SPLICER: \$1.00 per hour above Electrician rate.

TUNNEL WORK: 10% above Electrician rate.

#### ZONE PAY:

Zone A - 80 road miles from Post Office, 455 Orange Show Lane, San Bernardino, will be a free zone for all contractors

Zone B - Any work performed outside Zone A's 80 road miles, shall add \$8.00 per hour to the current wage scale.

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ELEV0018-001 09/15/2001

	Rates	Fringes
Elevator Mechanic.....	\$ 33.695	7.455

#### FOOTNOTE:

Vacation Pay: 8% with 5 or more years of service, 6% for 6 months to 5 years service. Paid Holidays: New Years Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day and Friday after, and Christmas Day.

	Rates	Fringes
Power equipment operator - cranes, piledriving, hoisting		
GROUP 1.....	\$ 29.95	14.55
GROUP 2.....	\$ 30.73	14.55
GROUP 3.....	\$ 31.02	14.55
GROUP 4.....	\$ 31.16	14.55
GROUP 5.....	\$ 31.38	14.55
GROUP 6.....	\$ 31.49	14.55
GROUP 7.....	\$ 31.61	14.55
GROUP 8.....	\$ 31.78	14.55
GROUP 9.....	\$ 31.95	14.55
GROUP 10.....	\$ 32.95	14.55
GROUP 11.....	\$ 33.95	14.55
GROUP 12.....	\$ 34.95	14.55
GROUP 13.....	\$ 35.95	14.55
Power equipment operator - tunnel work		
GROUP 1.....	\$ 31.23	14.55
GROUP 2.....	\$ 31.52	14.55
GROUP 3.....	\$ 31.66	14.55
GROUP 4.....	\$ 31.88	14.55
GROUP 5.....	\$ 31.99	14.55
GROUP 6.....	\$ 32.11	14.55
GROUP 7.....	\$ 32.41	14.55
Power equipment operators:		
GROUP 1.....	\$ 28.60	14.55
GROUP 2.....	\$ 29.38	14.55
GROUP 3.....	\$ 29.67	14.55
GROUP 4.....	\$ 31.16	14.55
GROUP 5.....	\$ 32.26	14.55
GROUP 6.....	\$ 31.38	14.55
GROUP 7.....	\$ 32.48	14.55
GROUP 8.....	\$ 31.49	14.55
GROUP 9.....	\$ 32.59	14.55
GROUP 10.....	\$ 31.61	14.55
GROUP 11.....	\$ 32.71	14.55
GROUP 12.....	\$ 31.78	14.55
GROUP 13.....	\$ 31.88	14.55
GROUP 14.....	\$ 31.91	14.55
GROUP 15.....	\$ 31.99	14.55
GROUP 16.....	\$ 32.11	14.55
GROUP 17.....	\$ 32.28	14.55
GROUP 18.....	\$ 32.38	14.55
GROUP 19.....	\$ 32.49	14.55
GROUP 20.....	\$ 32.61	14.55
GROUP 21.....	\$ 32.78	14.55
GROUP 22.....	\$ 32.88	14.55
GROUP 23.....	\$ 32.99	14.55
GROUP 24.....	\$ 33.11	14.55
GROUP 25.....	\$ 33.28	14.55

FOOTNOTES:

PREMIUM PAY of \$3.75 per hour shall be paid on all power

equipment operator work at Camp Pendleton, Point Arguello, and Vandenburg AFB.

Workers required to suit up and work in a hazardous material environment: \$2.00 per hour additional. Combination mixer and compressor operator on gunite work shall be classified as a concrete mobile mixer operator.

#### POWER EQUIPMENT OPERATORS CLASSIFICATIONS

GROUP 1: Bargeman; Brakeman; Compressor operator; Ditch Witch, with seat or similar type equipment; Elevator operator-inside; Engineer Oiler; Forklift operator (includes loed, lull or similar types under 5 tons; Generator operator; Generator, pump or compressor plant operator; Pump operator; Signalman; Switchman

GROUP 2: Asphalt-rubber plant operator (nurse tank operator); Concrete mixer operator-skip type; Conveyor operator; Fireman; Forklift operator (includes loed, lull or similar types over 5 tons; Hydrostatic pump operator; oiler crusher (asphalt or concrete plant); Petromat laydown machine; PJU side dum jack; Screening and conveyor machine operator (or similar types); Skiploader (wheel type up to 3/4 yd. without attachment); Tar pot fireman; Temporary heating plant operator; Trenching machine oiler

GROUP 3: Asphalt-rubber blend operator; Bobcat or similar type (side steer); Equipment greaser (rack); Ford Ferguson (with dragtype attachments); Helicopter radioman (ground); Stationary pipe wrapping and cleaning machine operator

GROUP 4: Asphalt plant fireman; Backhoe operator (mini-max or similar type); Boring machine operator; Boxman or mixerman (asphalt or concrete); Chip spreading machine operator; Concrete cleaning decontamination machine operator; Concrete Pump Operator (small portable); Drilling machine operator, small auger types (Texoma super economatic or similar types - Hughes 100 or 200 or similar types - drilling depth of 30' maximum); Equipment greaser (grease truck); Guard rail post driver operator; Highline cableway signalman; Horizontal Directional Drilling Machine; Hydra-hammer-aero stomper; Micro Tunneling (above ground tunnel); Power concrete curing machine operator; Power concrete saw operator; Power-driven jumbo form setter operator; Power sweeper operator; Rock Wheel Saw/Trencher; Roller operator (compacting); Screed operator (asphalt or concrete); Trenching machine operator (up to 6 ft.); Vacuum or much truck

GROUP 5: Equipment Greaser (Grease Truck/Multi Shift).

GROUP 6: Articulating material hauler; Asphalt plant engineer; Batch plant operator; Bit sharpener; Concrete joint machine operator (canal and similar type); Concrete planer operator; Dandy digger; Deck engine operator; Derrickman (oilfield type); Drilling machine operator, bucket or auger types (Calweld 100 bucket or similar types

- Watson 1000 auger or similar types - Texoma 330, 500 or 600 auger or similar types - drilling depth of 45' maximum); Drilling machine operator (including water wells); Hydrographic seeder machine operator (straw, pulp or seed), Jackson track maintainer, or similar type; Kalamazoo Switch tamper, or similar type; Machine tool operator; Maginnis internal full slab vibrator, Mechanical berm, curb or gutter (concrete or asphalt); Mechanical finisher operator (concrete, Clary-Johnson-Bidwell or similar); Micro tunnel system (below ground); Pavement breaker operator (truck mounted); Road oil mixing machine operator; Roller operator (asphalt or finish), rubber-tired earth moving equipment (single engine, up to and including 25 yds. struck); Self-propelled tar pipelining machine operator; Skiploader operator (crawler and wheel type, over 3/4 yd. and up to and including 1-1/2 yds.); Slip form pump operator (power driven hydraulic lifting device for concrete forms); Tractor operator-bulldozer, tamper-scraper (single engine, up to 100 h.p. flywheel and similar types, up to and including D-5 and similar types); Tugger hoist operator (1 drum); Ultra high pressure waterjet cutting tool system operator; Vacuum blasting machine operator

#### GROUP 7: Welder - General

GROUP 8: Asphalt or concrete spreading operator (tamping or finishing); Asphalt paving machine operator (Barber Greene or similar type); Asphalt-rubber distribution operator; Backhoe operator (up to and including 3/4 yd.), small ford, Case or similar; Cast-in-place pipe laying machine operator; Combination mixer and compressor operator (gunite work); Compactor operator (self-propelled); Concrete mixer operator (paving); Crushing plant operator; Drill Doctor; Drilling machine operator, Bucket or auger types (Calweld 150 bucket or similar types - Watson 1500, 2000 2500 auger or similar types - Texoma 700, 800 auger or similar types - drilling depth of 60' maximum); Elevating grader operator; Grade checker; Gradall operator; Grouting machine operator; Heavy-duty repairman; Heavy equipment robotics operator; Kalamazoo balliste regulator or similar type; Kolman belt loader and similar type; Le Tourneau blob compactor or similar type; Loader operator (Athey, Euclid, Sierra and similar types); Mobark Chipper or similar; Ozzie padder or similar types; P.C. slot saw; Pneumatic concrete placing machine operator (Hackley-Presswell or similar type); Pumpcrete gun operator; Rock Drill or similar types; Rotary drill operator (excluding caisson type); Rubber-tired earth-moving equipment operator (single engine, caterpillar, Euclid, Athey Wagon and similar types with any and all attachments over 25 yds. up to and including 50 cu. yds. struck); Rubber-tired earth-moving equipment operator (multiple engine up to and including 25 yds. struck); Rubber-tired scraper operator (self-loading paddle wheel type-John Deere, 1040 and similar single unit); Self-propelled curb and gutter machine operator; Shuttle buggy; Skiploader operator (crawler and wheel type over 1-1/2 yds. up to and including 6-1/2 yds.); Soil remediation plant

operator; Surface heaters and planer operator; Tractor compressor drill combination operator; Tractor operator (any type larger than D-5 - 100 flywheel h.p. and over, or similar-bulldozer, tamper, scraper and push tractor single engine); Tractor operator (boom attachments), Traveling pipe wrapping, cleaning and bending machine operator; Trenching machine operator (over 6 ft. depth capacity, manufacturer's rating); trenching Machine with Road Miner attachment (over 6 ft depth capacity): Ultra high pressure waterjet cutting tool system mechanic; Water pull (compaction) operator

GROUP 9: Heavy Duty Repairman

GROUP 10: Drilling machine operator, Bucket or auger types (Calweld 200 B bucket or similar types-Watson 3000 or 5000 auger or similar types-Texoma 900 auger or similar types-drilling depth of 105' maximum); Dual drum mixer, dynamic compactor LDC350 (or similar types); Monorail locomotive operator (diesel, gas or electric); Motor patrol-blade operator (single engine); Multiple engine tractor operator (Euclid and similar type-except Quad 9 cat.); Rubber-tired earth-moving equipment operator (single engine, over 50 yds. struck); Pneumatic pipe ramming tool and similar types; Prestressed wrapping machine operator; Rubber-tired earth-moving equipment operator (single engine, over 50 yds. struck); Rubber tired earth moving equipment operator (multiple engine, Euclid, caterpillar and similar over 25 yds. and up to 50 yds. struck), Tower crane repairman; Tractor loader operator (crawler and wheel type over 6-1/2 yds.); Woods mixer operator (and similar Pugmill equipment)

GROUP 11: Heavy Duty Repairman - Welder Combination, Welder - Certified.

GROUP 12: Auto grader operator; Automatic slip form operator; Drilling machine operator, bucket or auger types (Calweld, auger 200 CA or similar types - Watson, auger 6000 or similar types - Hughes Super Duty, auger 200 or similar types - drilling depth of 175' maximum); Hoe ram or similar with compressor; Mass excavator operator less tha 750 cu. yards; Mechanical finishing machine operator; Mobile form traveler operator; Motor patrol operator (multi-engine); Pipe mobile machine operator; Rubber-tired earth- moving equipment operator (multiple engine, Euclid, Caterpillar and similar type, over 50 cu. yds. struck); Rubber-tired self- loading scraper operator (paddle-wheel-auger type self-loading - two (2) or more units)

GROUP 13: Rubber-tired earth-moving equipment operator operating equipment with push-pull system (single engine, up to and including 25 yds. struck)

GROUP 14: Canal liner operator; Canal trimmer operator; Remote- control earth-moving equipment operator (operating a second piece of equipment: \$1.00 per hour additional);

Wheel excavator operator (over 750 cu. yds.)

GROUP 15: Rubber-tired earth-moving equipment operator, operating equipment with push-pull system (single engine, Caterpillar, Euclid, Athey Wagon and similar types with any and all attachments over 25 yds. and up to and including 50 yds. struck); Rubber-tired earth-moving equipment operator, operating equipment with push-pull system (multiple engine-up to and including 25 yds. struck)

GROUP 16: Rubber-tired earth-moving equipment operator, operating equipment with push-pull system (single engine, over 50 yds. struck); Rubber-tired earth-moving equipment operator, operating equipment with push-pull system (multiple engine, Euclid, Caterpillar and similar, over 25 yds. and up to 50 yds. struck)

GROUP 17: Rubber-tired earth-moving equipment operator, operating equipment with push-pull system (multiple engine, Euclid, Caterpillar and similar, over 50 cu. yds. struck); Tandem tractor operator (operating crawler type tractors in tandem - Quad 9 and similar type)

GROUP 18: Rubber-tired earth-moving equipment operator, operating in tandem (scrapers, belly dumps and similar types in any combination, excluding compaction units - single engine, up to and including 25 yds. struck)

GROUP 19: Rotex concrete belt operator (or similar types); Rubber-tired earth-moving equipment operator, operating in tandem (scrapers, belly dumps and similar types in any combination, excluding compaction units - single engine, Caterpillar, Euclid, Athey Wagon and similar types with any and all attachments over 25 yds. and up to and including 50 cu. yds. struck); Rubber-tired earth-moving equipment operator, operating in tandem (scrapers, belly dumps and similar types in any combination, excluding compaction units - multiple engine, up to and including 25 yds. struck)

GROUP 20: Rubber-tired earth-moving equipment operator, operating in tandem (scrapers, belly dumps and similar types in any combination, excluding compaction units - single engine, over 50 yds. struck); Rubber-tired earth-moving equipment operator, operating in tandem (scrapers, belly dumps, and similar types in any combination, excluding compaction units - multiple engine, Euclid, Caterpillar and similar, over 25 yds. and up to 50 yds. struck)

GROUP 21: Rubber-tired earth-moving equipment operator, operating in tandem (scrapers, belly dumps and similar types in any combination, excluding compaction units - multiple engine, Euclid, Caterpillar and similar type, over 50 cu. yds. struck)

GROUP 22: Rubber-tired earth-moving equipment operator, operating equipment with the tandem push-pull system

(single engine, up to and including 25 yds. struck)

GROUP 23: Rubber-tired earth-moving equipment operator, operating equipment with the tandem push-pull system (single engine, Caterpillar, Euclid, Athey Wagon and similar types with any and all attachments over 25 yds. and up to and including 50 yds. struck); Rubber-tired earth-moving equipment operator, operating with the tandem push-pull system (multiple engine, up to and including 25 yds. struck)

GROUP 24: Rubber-tired earth-moving equipment operator, operating equipment with the tandem push-pull system (single engine, over 50 yds. struck); Rubber-tired earth-moving equipment operator, operating equipment with the tandem push-pull system (multiple engine, Euclid, Caterpillar and similar, over 25 yds. and up to 50 yds. struck)

GROUP 25: Concrete pump operator-truck mounted; Rubber-tired earth-moving equipment operator, operating equipment with the tandem push-pull system (multiple engine, Euclid, Caterpillar and similar type, over 50 cu. yds. struck)

#### CRANES, PILEDRIVING AND HOISTING EQUIPMENT CLASSIFICATIONS

GROUP 1: Engineer oiler; Fork lift operator (includes loed, lull or similar types)

GROUP 2: Truck crane oiler

GROUP 3: A-frame or winch truck operator; Ross carrier operator (jobsite)

GROUP 4: Bridge-type unloader and turntable operator; Helicopter hoist operator

GROUP 5: Hydraulic boom truck; Stinger crane (Austin-Western or similar type); Tugger hoist operator (1 drum)

GROUP 6: Bridge crane operator; Cretor crane operator; Hoist operator (Chicago boom and similar type); Lift mobile operator; Lift slab machine operator (Vagtborg and similar types); Material hoist and/or manlift operator; Polar gantry crane operator; Self Climbing scaffold (or similar type); Shovel, backhoe, dragline, clamshell operator (over 3/4 yd. and up to 5 cu. yds. mrc); Tugger hoist operator

GROUP 7: Pedestal crane operator; Shovel, backhoe, dragline, clamshell operator (over 5 cu. yds. mrc); Tower crane repair; Tugger hoist operator (3 drum)

GROUP 8: Crane operator (up to and including 25 ton capacity); Crawler transporter operator; Derrick barge operator (up to and including 25 ton capacity); Hoist operator, stiff legs, Guy derrick or similar type (up to and including 25 ton capacity); Shovel, backhoe, dragline,

clamshell operator (over 7 cu. yds., M.R.C.)

GROUP 9: Crane operator (over 25 tons and up to and including 50 tons mrc); Derrick barge operator (over 25 tons up to and including 50 tons mrc); Highline cableway operator; Hoist operator, stiff legs, Guy derrick or similar type (over 25 tons up to and including 50 tons mrc); K-crane operator; Polar crane operator; Self erecting tower crane operator maximum lifting capacity ten tons

GROUP 10: Crane operator (over 50 tons and up to and including 100 tons mrc); Derrick barge operator (over 50 tons up to and including 100 tons mrc); Hoist operator, stiff legs, Guy derrick or similar type (over 50 tons up to and including 100 tons mrc), Mobile tower crane operator (over 50 tons, up to and including 100 tons M.R.C.); Tower crane operator and tower gantry

GROUP 11: Crane operator (over 100 tons and up to and including 200 tons mrc); Derrick barge operator (over 100 tons up to and including 200 tons mrc); Hoist operator, stiff legs, Guy derrick or similar type (over 100 tons up to and including 200 tons mrc); Mobile tower crane operator (over 100 tons up to and including 200 tons mrc)

GROUP 12: Crane operator (over 200 tons up to and including 300 tons mrc); Derrick barge operator (over 200 tons up to and including 300 tons mrc); Hoist operator, stiff legs, Guy derrick or similar type (over 200 tons, up to and including 300 tons mrc); Mobile tower crane operator (over 200 tons, up to and including 300 tons mrc)

GROUP 13: Crane operator (over 300 tons); Derrick barge operator (over 300 tons); Helicopter pilot; Hoist operator, stiff legs, Guy derrick or similar type (over 300 tons); Mobile tower crane operator (over 300 tons)

#### TUNNEL CLASSIFICATIONS

GROUP 1: Skiploader (wheel type up to 3/4 yd. without attachment)

GROUP 2: Power-driven jumbo form setter operator

GROUP 3: Dinkey locomotive or motorperson (up to and including 10 tons)

GROUP 4: Bit sharpener; Equipment greaser (grease truck); Slip form pump operator (power-driven hydraulic lifting device for concrete forms); Tugger hoist operator (1 drum); Tunnel locomotive operator (over 10 and up to and including 30 tons)

GROUP 5: Backhoe operator (up to and including 3/4 yd.); Small Ford, Case or similar; Drill doctor; Grouting machine operator; Heading shield operator; Heavy-duty repairperson; Loader operator (Athey, Euclid, Sierra and similar types);

Mucking machine operator (1/4 yd., rubber-tired, rail or track type); Pneumatic concrete placing machine operator (Hackley-Presswell or similar type); Pneumatic heading shield (tunnel); Pumpcrete gun operator; Tractor compressor drill combination operator; Tugger hoist operator (2 drum); Tunnel locomotive operator (over 30 tons)

GROUP 6: Heavy Duty Repairman

GROUP 7: Tunnel mole boring machine operator

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 ENGI0012-004 08/01/2003

	Rates	Fringes
Power equipment operators:		
DREDGING:		
(1) Leverman.....	\$ 34.95	13.22
(2) Dredge dozer.....	\$ 32.24	13.22
(3) Deckmate.....	\$ 31.37	13.22
(4) Winch operator (stern winch on dredge).....	\$ 30.82	13.22
(5) Fireman; Deckhand and Bargeman.....	\$ 30.28	13.20
(6) Barge Mate.....	\$ 30.89	13.22

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 IRON0002-004 07/01/2004

	Rates	Fringes
Ironworkers:		
Fence Erector.....	\$ 27.02	14.74
Ornamental, Reinforcing and Structural.....	\$ 27.91	14.74

PREMIUM PAY:

\$3.00 additional per hour at the following locations:

China Lake Naval Test Station, Chocolate Mountains Naval Reserve-Niland, Edwards AFB, Fort Irwin Military Station, Fort Irwin Training Center-Goldstone, San Clemente Island, San Nicholas Island, Susanville Federal Prison, 29 Palms - Marine Corps, U.S. Marine Base - Barstow, U.S. Naval Air Facility - Sealey, Vandenberg AFB

\$2.00 additional per hour at the following locations:

Army Defense Language Institute - Monterey, Fallon Air Base, Naval Post Graduate School - Monterey, Yermo Marine Corps Logistics Center

\$1.00 additional per hour at the following locations:

Port Hueneme, Port Mugu, U.S. Coast Guard Station - Two Rock

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 LABO0300-001 07/01/2004

	Rates	Fringes
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Brick Tender.....	\$ 21.60	11.72
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LABO0300-008 08/04/2004

	Rates	Fringes
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Plaster Clean-up Laborer.....	\$ 20.74	12.11
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Work at Military Bases - \$3.00 additional per hour:  
 Coronado Naval Amphibious Base, Fort Irwin, George AFB,  
 Marine Corps Air Station-29 Palms, Imperial Beach Naval Air  
 Station, Marine Corps Logistics Supply Base, Marine Corps  
 Pickle Meadows, Mountain Warfare Training Center, Naval  
 Air Facility-Seeley, North Island Naval Air Station,  
 Vandenberg AFB.

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LABO0882-002 01/01/2004

	Rates	Fringes
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Asbestos Removal Laborer.....	\$ 22.00	9.20
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SCOPE OF WORK: Includes site mobilization, initial site  
 cleanup, site preparation, removal of asbestos-containing  
 material and toxic waste, encapsulation, enclosure and  
 disposal of asbestos- containing materials and toxic waste  
 by hand or with equipment or machinery; scaffolding,  
 fabrication of temporary wooden barriers and assembly of  
 decontamination stations.

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LABO1184-001 07/01/2004

	Rates	Fringes
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Laborers:

STRIPING/SLURRY SEAL

GROUP 1.....	\$ 22.16	10.39
GROUP 2.....	\$ 23.41	10.39
GROUP 3.....	\$ 25.34	10.39
GROUP 4.....	\$ 27.01	10.39

STRIPING

GROUP 1.....	\$ 22.16	10.39
GROUP 2.....	\$ 23.41	10.39
GROUP 3.....	\$ 25.34	10.39
GROUP 4.....	\$ 27.01	10.39

LABORERS - STRIPING CLASSIFICATIONS

GROUP 1: Protective coating, pavement sealing, including  
 repair and filling of cracks by any method on any surface  
 in parking lots, game courts and playgrounds; carstops;  
 operation of all related machinery and equipment; equipment  
 repair technician

GROUP 2: Traffic surface abrasive blaster; pot tender -  
 removal of all traffic lines and markings by any method

(sandblasting, waterblasting, grinding, etc.) and preparation of surface for coatings. Traffic control person: controlling and directing traffic through both conventional and moving lane closures; operation of all related machinery and equipment

GROUP 3: Traffic delineating device applicator: Layout and application of pavement markers, delineating signs, rumble and traffic bars, adhesives, guide markers, other traffic delineating devices including traffic control. This category includes all traffic related surface preparation (sandblasting, waterblasting, grinding) as part of the application process. Traffic protective delineating system installer: removes, relocates, installs, permanently affixed roadside and parking delineation barricades, fencing, cable anchor, guard rail, reference signs, monument markers; operation of all related machinery and equipment; power broom sweeper

GROUP 4: Striper: layout and application of traffic stripes and markings; hot thermo plastic; tape traffic stripes and markings, including traffic control; operation of all related machinery and equipment

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\* PAIN0036-001 07/01/2004

	Rates	Fringes
Painters:		
(1) Repaint Including Lead		
Abatement.....	\$ 22.80	7.19
(2) All Other Work:.....	\$ 26.07	7.19

REPAINT of any structure with the exception of work involving the aerospace industry, breweries, commercial recreational facilities, hotels which operate commercial establishments as part of hotel service, and sports facilities, tenant improvement work not included in conjunction with the construction of the building and all repainting of tenant improvement projects.

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PAIN0036-008 01/01/2004

	Rates	Fringes
Drywall Finisher.....	\$ 26.83	9.23

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PAIN0036-015 06/01/2004

	Rates	Fringes
Glazier.....	\$ 30.20	10.55

FOOTNOTE: Additional \$1.25 per hour for work in a condo, from the third (3rd) floor and up Additional \$1.25 per hour for work on the outside of the building from a swing state or any suspended contrivance, from the ground up

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\* PAIN1247-002 01/01/2005

	Rates	Fringes
Soft Floor Layer.....	\$ 28.05	7.15

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PLAS0200-008 08/07/2002

	Rates	Fringes
Plasterer		
FORT IRWIN; GEORGE AIR		
FORCE BASE; MAARINE CORPS		
AIR STATION 29 PALM, ; AND		
MARINE CORPS LOGISTICS		
SUPPLY BASE:.....	\$ 29.77	6.76
REMAINDER OF COUNTY:.....	\$ 26.77	6.76

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PLAS0500-002 07/01/2004

	Rates	Fringes
Cement Mason.....	\$ 24.20	14.59

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PLUM0016-002 07/01/2004

	Rates	Fringes
Plumber, Pipefitter, Steamfitter		
(1) Work on strip malls, light commercial, tenant improvement and remodel work	\$ 24.19	9.34
(1) Work on strip malls, light commercial, tenant improvement and remodel work	\$ 24.19	9.34
(2) Work on new additions and remodeling of bars, restaurants, stores and commercial buildings, not to exceed 5,000 sq. ft. of floor space.....	\$ 30.32	10.67
(2) Work on new additions and remodeling of bars, restaurants, stores and commercial buildings, not to exceed 5,000 sq. ft. of floor space.....	\$ 30.32	10.67
(3) Edwards AFB & George AFB	\$ 33.61	11.24
(3) Edwards AFB and George AFB.....	\$ 33.61	11.24
Edwards AFB & George AFB...	\$ 33.61	11.24
(4) All other work.....	\$ 31.36	11.24
(4) Fort Irwin Army Base, Marine Corps Logistic Base at Nebo and Yermo, and		

Twenty-Nine Palms Marine Base.....	\$ 34.86	11.24
Fort Irwin Army Base, Marine Corps Logistic Base at Nebo, Marine Corps Logistic Base at Yermo and Twenty-Nine Palms Marine Base.....	\$ 34.86	11.24
(4) Fort Irwin Army Base, Marine Corps Logistic Base at Nebo, Marine Corps Logistic Base at Yermo and Twenty-Nine Palms Marine Base.....	\$ 34.86	11.24
(5) All other work.....	\$ 31.36	11.24
Remainder of County.....	\$ 31.36	11.24

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PLUM0345-001 07/01/2004

	Rates	Fringes
Landscape & Irrigation Fitter..	\$ 24.23	10.60
Sewer & Storm Drain Work....	\$ 21.06	10.98

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ROOF0036-002 03/31/2003

	Rates	Fringes
Roofer (including Built Up, Composition and Single Ply) PREPARER Duties limited to the following: Roof removal of any type of roofing or roofing material; or spudding, or sweeping; and/or clean-up; and/or preload in, or in preparing the roof for application of roofing, damp and/or waterproofing materials.....	\$ 26.17	5.80
ROOFER.....	\$ 25.17	6.05

FOOTNOTE: Pitch premium: Work on which employees are exposed to pitch fumes or required to handle pitch, pitch base or pitch impregnated products, or any material containing coal tar pitch, the entire roofing crew shall receive \$1.75 per hour "pitch premium" pay.

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\* SFCA0669-009 01/01/2005

DOES NOT INCLUDE THE NORTHERN PART OF THE CITY OF CHINO, OR THE CITIES OF MONTCLAIR OR ONTARIO:

Rates	Fringes
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Sprinkler Fitter, Fire.....\$ 26.75	12.25
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 \* SFCA0709-004 01/01/2005

THE NORTHERN PART OF THE CITY OF CHINO, AND THE CITIES OF  
 MONTCLAIR AND ONTARIO:

	Rates	Fringes
Sprinkler Fitter (FIRE).....\$ 31.68		15.15

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 SHEE0105-003 08/01/2004

INYO, KERN (Northeast part, East of Hwy 395), LOS ANGELES  
 (Including Pomona, Claremont, Catalina Island, Long Beach and  
 area South of Imperial highway and East of the Los Angeles  
 River), MONO ORANGE, RIVERSIDE, AND SAN BERNARDINO COUNTIES

	Rates	Fringes
Sheet metal worker		
(1) Commercial - New		
Construction and Remodel		
work.....\$ 30.27		13.82
(2) Industrial work		
including air pollution		
control systems, noise		
abatement, hand rails,		
guard rails, excluding		
aritechtrual sheet metal		
work, excluding A-C,		
heating, ventilating		
systems for human comfort...\$ 26.86		17.62

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 TEAM0011-002 07/01/2004

	Rates	Fringes
Truck drivers:		
GROUP 1.....\$ 23.24		13.44
GROUP 2.....\$ 23.39		13.44
GROUP 3.....\$ 23.52		13.44
GROUP 4.....\$ 23.71		13.44
GROUP 5.....\$ 23.65		13.44
GROUP 6.....\$ 23.77		13.44
GROUP 7.....\$ 24.02		13.44
GROUP 8.....\$ 24.27		13.44
GROUP 9.....\$ 24.47		13.44
GROUP 10.....\$ 24.77		13.44
GROUP 11.....\$ 25.27		13.44

WORK ON ALL MILITARY BASES:

PREMIUM PAY: \$3.00 per hour additional.

[29 palms Marine Base, Camp Roberts, China Lake, Edwards AFB,  
 Fort Irwin, George AFB, Marine Corps Logistics Base at Nebo  
 & Yermo, Mountain Warfare Training Center, Bridgeport,  
 Point Arguello, Point Conception, Vandenberg AFB]

## TRUCK DRIVERS CLASSIFICATIONS

### GROUP 1: Truck driver

GROUP 2: Driver of vehicle or combination of vehicles - 2 axles; Traffic control pilot car excluding moving heavy equipment permit load; Truck mounted broom

GROUP 3: Driver of vehicle or combination of vehicles - 3 axles; Boot person; Cement mason distribution truck; Fuel truck driver; Water truck - 2 axle; Dump truck, less than 16 yds. water level; Erosion control driver

GROUP 4: Driver of transit mix truck, under 3 yds.; Dumpcrete truck, less than 6-1/2 yds. water level

GROUP 5: Water truck, 3 or more axles; Truck greaser and tire person (\$0.50 additional for tire person); Pipeline and utility working truck driver, including winch truck and plastic fusion, limited to pipeline and utility work; Slurry truck driver

GROUP 6: Transit mix truck, 3 yds. or more; Dumpcrete truck, 6-1/2 yds. water level and over; Vehicle or combination of vehicles - 4 or more axles; Oil spreader truck; Dump truck, 16 yds. to 25 yds. water level

GROUP 7: A Frame, Swedish crane or similar; Forklift driver; Ross carrier driver

GROUP 8: Dump truck, 25 yds. to 49 yds. water level; Truck repair person; Water pull - single engine; Welder

GROUP 9: Truck repair person/welder; Low bed driver, 9 axles or over

GROUP 10: Dump truck - 50 yds. or more water level; Water pull - single engine with attachment

GROUP 11: Water pull - twin engine; Water pull - twin engine with attachments; Winch truck driver - \$1.25 additional when operating winch or similar special attachments

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WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.  
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Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).  
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In the listing above, the "SU" designation means that rates

listed under the identifier do not reflect collectively bargained wage and fringe benefit rates. Other designations indicate unions whose rates have been determined to be prevailing.

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WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

- \* an existing published wage determination
- \* a survey underlying a wage determination
- \* a Wage and Hour Division letter setting forth a position on a wage determination matter
- \* a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations  
Wage and Hour Division  
U.S. Department of Labor  
200 Constitution Avenue, N.W.  
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator  
U.S. Department of Labor  
200 Constitution Avenue, N.W.  
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board  
U.S. Department of Labor  
200 Constitution Avenue, N.W.  
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISION

# **COMMAMD AND CONTROL FACILITY FORT IRWIN, CALIFORNIA**

## **Sustainable Project Rating Tool (SPiRiT)**

**Version 1.4.1**

**U. S. Army Corps of Engineers  
U. S. Army Assistant Chief of Staff for Installation Management**

**June 2002**

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<b>NOTES .....</b>	<b>iii</b>
<b>1.0 Sustainable Sites.....</b>	<b>1</b>
<input type="checkbox"/> 1.R1 Erosion, Sedimentation and Water Quality Control <input type="checkbox"/> 1.C1 Site Selection <input type="checkbox"/> 1.C2 Installation/Base Redevelopment <input type="checkbox"/> 1.C3 Brownfield Redevelopment <input type="checkbox"/> 1.C4 Alternative Transportation <input type="checkbox"/> 1.C5 Reduced Site Disturbance	<input type="checkbox"/> 1.C6 Stormwater Management <input type="checkbox"/> 1.C7 Landscape and Exterior Design to Reduce Heat Islands <input type="checkbox"/> 1.C8 Light Pollution Reduction <input type="checkbox"/> 1.C9 Optimize Site Features <input type="checkbox"/> 1.C10 Facility Impact <input type="checkbox"/> 1.C11 Site Ecology
<b>2.0 Water Efficiency.....</b>	<b>5</b>
<input type="checkbox"/> 2.C1 Water Efficient Landscaping <input type="checkbox"/> 2.C2 Innovative Wastewater Technologies	<input type="checkbox"/> 2.C3 Water Use Reduction
<b>3.0 Energy and Atmosphere.....</b>	<b>6</b>
<input type="checkbox"/> 3.R1 Fundamental Building Systems Commissioning <input type="checkbox"/> 3.R2 Minimum Energy Performance <input type="checkbox"/> 3.R3 CFC Reduction in HVAC&R Equipment <input type="checkbox"/> 3.C1 Optimize Energy Performance <input type="checkbox"/> 3.C2 Renewable Energy	<input type="checkbox"/> 3.C3 Additional Commissioning <input type="checkbox"/> 3.C4 <<Deleted>> <input type="checkbox"/> 3.C5 Measurement and Verification <input type="checkbox"/> 3.C6 Green Power <input type="checkbox"/> 3.C7 Distributed Generation
<b>4.0 Materials and Resources.....</b>	<b>10</b>
<input type="checkbox"/> 4.R1 Storage & Collection of Recyclables <input type="checkbox"/> 4.C1 Building Reuse <input type="checkbox"/> 4.C2 Construction Waste Management <input type="checkbox"/> 4.C3 Resource Reuse	<input type="checkbox"/> 4.C4 Recycled Content <input type="checkbox"/> 4.C5 Local/Regional Materials <input type="checkbox"/> 4.C6 Rapidly Renewable Materials <input type="checkbox"/> 4.C7 Certified Wood
<b>5.0 Indoor Environmental Quality (IEQ) .....</b>	<b>13</b>
<input type="checkbox"/> 5.R1 Minimum IAQ Performance <input type="checkbox"/> 5.R2 Environmental Tobacco Smoke (ETS) Control <input type="checkbox"/> 5.C1 IAQ Monitoring <input type="checkbox"/> 5.C2 Increase Ventilation Effectiveness <input type="checkbox"/> 5.C3 Construction IAQ Management Plan <input type="checkbox"/> 5.C4 Low-Emitting Materials	<input type="checkbox"/> 5.C5 Indoor Chemical and Pollutant Source Control <input type="checkbox"/> 5.C6 Controllability of Systems <input type="checkbox"/> 5.C7 Thermal Comfort <input type="checkbox"/> 5.C8 Daylight and Views <input type="checkbox"/> 5.C9 Acoustic Environment /Noise Control <input type="checkbox"/> 5.C10 Facility In-Use IAQ Management Plan
<b>6.0 Facility Delivery Process .....</b>	<b>17</b>
<input type="checkbox"/> 6.C1 Holistic Delivery of Facility	
<b>7.0 Current Mission .....</b>	<b>18</b>
<input type="checkbox"/> 7.C1 Operation and Maintenance	<input type="checkbox"/> 7.C2 Soldier and Workforce Productivity and Retention
<b>8.0 Future Missions .....</b>	<b>19</b>
<input type="checkbox"/> 8.C1 Functional Life of Facility and Supporting Systems	<input type="checkbox"/> 8.C2 Adaptation, Renewal and Future Uses
<b>Facility Points Summary.....</b>	<b>20</b>
<b>SPiRiT Comment Sheet .....</b>	<b>22</b>

## NOTES

- 1) This Sustainable Project Rating Tool (SPiRiT) is derived from The U. S. Green Building Council LEED 2.0 (Leadership in Energy and Environmental Design) Green Building Rating System™.
- 2) The SPiRiT numbering scheme parallels, but does not match LEED 2.0. LEED does not number major sections, which it calls 'Credit Categories,' ex. 'Sustainable Sites,' rather it numbers criteria or 'credits' within each major section. SPiRiT credit numbers match those of LEED where there is a 1:1 comparison. Where additional credits have been added they fall at the end of major sections.
- 3) The SPiRiT Credits all follow the format: Intent, Requirement and Technologies/Strategies.  
Intent: A statement of the primary goal for the credit;  
Requirement: Quantifiable conditions necessary to achieve stated intent;  
Technologies/Strategies: Suggested technologies, strategies and referenced guidance on the means to achieve identified requirements.
- 4) Projects are evaluated for each SPiRiT credit which are either 'Prerequisites' or result in a point score:  
Prerequisites: These credits are a statement of minimum requirements and must be met. No further points will be awarded unless the minimum is achieved. These credits are recognizable by an 'R' in the number scheme, ex. 1.R1, and a 'Reqd.' in the score column.  
Point Score: These credits are evaluated and result in a point score. Where the potential score is greater than 1, no partial points are granted.
- 5) SPiRiT Sustainable Project Certification Levels:

SPiRiT Bronze	25 to 34 Points
SPiRiT Silver	35 to 49 Points
SPiRiT Gold	50 to 74 Points
SPiRiT Platinum	75 to 100 Points
- 6) SPiRiT credits have been developed to address facility life cycle phases including programming, design, construction, and commissioning. Additional rating tools will be developed to address installation/base master planning and facilities operations and maintenance, rehabilitation, recycling, and disposal.
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- 9) Army/USACE employees are members of the USGBC with membership privileges accessible via the USGBC web site, <http://www.usgbc.org>. For information on membership and access to available LEED resources to support use of SPiRiT and sustainable design in your projects, contact Richard Schneider at (217) 373-6752 or [richard.l.schneider@erdc.usace.army.mil](mailto:richard.l.schneider@erdc.usace.army.mil) (Annette Stumpf at (217) 352-6511 ext. 7542 or [annette.l.stumpf@erdc.usace.army.mil](mailto:annette.l.stumpf@erdc.usace.army.mil) alternate).
- 10) For the latest information on SPiRiT and for access to guidance, tools and resources supporting sustainable design initiatives, visit the CERL 'Sustainable Design and Development Resource' website, <http://www.cecer.army.mil/SustDesign>. There you may also join the CERL Sustainable Design ListServ to be directly notified of information pertinent to sustainable design.

1.0	Sustainable Sites	Score	20
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<b>1.R1</b>	<b><u>Erosion, Sedimentation, and Water Quality Control</u> <sup>(1)</sup></b>	<b>Reqd.</b>
Intent:	Control erosion and pollutants to reduce negative impacts on water and air quality.	
Requirement:	<input type="checkbox"/> Design a site sediment and erosion control plan and a pollution prevention plan that conforms to best management practices in the EPA's Storm Water Management for Construction Activities, EPA Document No. EPA-833-R-92-001, Chapter 3, OR local Erosion and Sedimentation Control standards and codes, whichever is more stringent. The plan shall meet the following objectives: <ul style="list-style-type: none"> <li>▪ Prevent loss of soil during construction by storm water runoff and/or wind erosion, including protecting topsoil by stockpiling for reuse.</li> <li>▪ Prevent sedimentation of storm sewer or receiving streams and/or air pollution with dust and particulate matter.</li> <li>▪ Prevent hazardous material discharge into storm water systems.</li> <li>▪ Prevent petroleum oils and lubricants (POL) discharge into storm water systems.</li> </ul>	
Technologies /Strategies:	The EPA standard lists numerous measures such as silt fencing, sediment traps, oil grit separators, construction phasing, stabilization of steep slopes, maintaining vegetated ground cover and providing ground cover that will meet this prerequisite.	
<b>1.C1</b>	<b><u>Site Selection</u> <sup>(1)</sup></b>	
Intent:	Avoid development of inappropriate sites and reduce the environmental impact from the location of a building on a site. Select site based on functional adjacencies/relationships and land use compatibility.	
Requirement:	<input type="checkbox"/> Do not develop buildings on portions of sites that meet any one of the following criteria: <ul style="list-style-type: none"> <li>▪ Prime training or maneuver land.</li> <li>▪ Land whose elevation is lower than 5 ft. above the 100-year flood elevation as defined by FEMA.</li> <li>▪ Land that provides habitat for any species on the Federal or State threatened or endangered list.</li> <li>▪ Within 100 feet of any wetland as defined by 40 CFR, Parts 230-233 and Part 22, OR as defined by local or state rule or law, whichever is more stringent.</li> </ul>	<b>1</b>
	<input type="checkbox"/> Select site based on functional adjacencies/relationships and land use compatibility. <ul style="list-style-type: none"> <li>▪ Select sites close to existing roads and utilities or use an existing structure to minimize the need for new infrastructure.</li> <li>▪ Select site in area of high density.</li> <li>▪ Site facilities based on the strength of their relationships to other facilities/land-uses to limit travel distances. The stronger the relationship/functional interaction, the closer the distance between two facilities.</li> <li>▪ Select for distance to installation/base transit systems and access to pedestrian ways and bike paths.</li> <li>▪ Select for development previously used or developed suitable and available sites.</li> </ul>	<b>1</b>
Technologies /Strategies:	Screen potential building sites for these criteria and/or ensure that these criteria are addressed by the designer during the conceptual design phase. Utilize landscape architects, ecologists, environmental engineers, civil engineers, and similar professionals for the screening process. New wetlands constructed as part of stormwater mitigation or other site restoration efforts are not affected by the restrictions of this prerequisite.	

<sup>(1)</sup> Adapted material not reviewed or endorsed by U. S. Green Building Council.

## 1.0 Sustainable Sites (Continued)

### 1.C2 Installation/Base Redevelopment <sup>(1)</sup>

Intent: Channel development to installation/base cantonment areas with existing infrastructure, protecting greenfields and preserving habitat and natural resources.

Requirement: ☐ Increase localized density to conform to existing or desired density goals by utilizing sites that are located within existing cantonment areas of high development density. **1**

☐ Select sites close to existing roads and utilities or use an existing structure to minimize the need for new infrastructure. **1**

Technologies /Strategies: During the site selection process give preference to previously developed sites with installation/base cantonment redevelopment potential such as facility reduction program cleared sites.

### 1.C3 Brownfield Redevelopment <sup>(1)</sup>

Intent: Rehabilitate damaged sites where development is complicated by real or perceived environmental contamination, reducing pressure on undeveloped land.

Requirement: ☐ Develop on a site classified as a brownfield and provide remediation as required by EPA's Brownfield Redevelopment program requirements OR Develop a brownfield site (a site that has been contaminated by previous uses). **0**

Technologies /Strategies: Screen potential damaged sites for these criteria prior to selection for rehabilitation.

Utilize EPA OSWER Directive 9610.17 and ASTM Standard Practice E1739 for site remediation where required.

### 1.C4 Alternative Transportation <sup>(1)</sup>

Intent: Reduce pollution and land development impacts from automobile use.

Requirement: ☐ Locate building within ½ mile of installation/base transit systems. **1**

☐ Provide suitable means for securing bicycles, with convenient changing/shower facilities for use by cyclists, for 5% or more of building occupants.

☐ Locate building within 2 miles of alternative-fuel refueling station(s). **1**

☐ Size parking capacity not to exceed minimum installation/base cantonment requirements AND provide preferred parking for carpools or van pools capable of serving 5% of the building occupants, OR, add no new parking for rehabilitation projects AND provide preferred parking for carpools or van pools capable of serving 5% of the building occupants. **1**

Technologies /Strategies: Select sites near public installation/base transit served by safe, convenient pedestrian pathways.

<sup>(1)</sup> Adapted material not reviewed or endorsed by U. S. Green Building Council.

## 1.0 Sustainable Sites (Continued)

### 1.C5 Reduced Site Disturbance <sup>(1)</sup>

Intent: Conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity.

- Requirement:
- ☐ On greenfield sites, limit site disturbance including earthwork and clearing of vegetation to 40 feet beyond the building perimeter, 5 feet beyond primary roadway curbs, walkways, and main utility branch trenches, and 25 feet beyond pervious paving areas that require additional staging areas in order to limit compaction in the paved area; OR, on previously developed sites, restore a minimum of 50% of the remaining open area by planting native or adapted vegetation. 1
  - ☐ Reduce the development footprint (including building, access roads and parking) to exceed the installation/base's/master plan local zoning's open space requirement for the site by 25% or in accordance with installation/base policy on open space set asides, whichever is greater. 1

Technologies /Strategies: Note requirements on plans and in specifications. Establish contractual penalties for destruction of trees and site areas noted for protection. Reduce footprints by tightening program needs and stacking floor plans. Establish clearly marked construction and disturbance boundaries. Delineate laydown, recycling, and disposal areas. Use areas to be paved as staging areas. Work with local horticultural extension services, native plant societies, or installation/base agronomy staff to select indigenous plant species for site restoration and landscaping.

### 1.C6 Stormwater Management <sup>(1)</sup>

Intent: Limit disruption of natural water flows by minimizing storm water runoff, increasing on-site infiltration and reducing contaminants.

- Requirement: Implement a stormwater management plan that results in:
- ☐ No net increase in the rate or quantity of stormwater runoff from undeveloped to developed conditions; OR, if existing imperviousness is greater than 50%, implement a stormwater management plan that results in a 25% decrease in the rate and quantity of stormwater runoff. 1
  - ☐ Treatment systems designed to remove 80% of the average annual post development total suspended solids (TSS), and 40% of the average annual post development total phosphorous (TP), by implementing Best Management Practices (BMPs) outlined in EPA's Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters (EPA-840-B-92-002 1/93). 1

Technologies /Strategies: Significantly reduce impervious surfaces, maximize on-site stormwater infiltration, and retain pervious and vegetated areas. Capture rainwater from impervious areas of the building for groundwater recharge or reuse within building. Use green/vegetated roofs. Utilize biologically-based and innovative stormwater management features for pollutant load reduction such as constructed wetlands, stormwater filtering systems, bioswales, bio-retention basins, and vegetated filter strips. Use open vegetated swales to reduce drainage velocity and erosion, reduce system maintenance, increase vegetative variety and support wildlife habitat where space permits.

### 1.C7 Landscape and Exterior Design to Reduce Heat Islands <sup>(2)</sup>

Intent: Reduce heat islands (thermal gradient differences between developed and undeveloped areas) to minimize impact on microclimate and human and wildlife habitat.

- Requirement:
- ☐ Provide shade (within 5 years) on at least 30% of non-roof impervious surface on the site, including parking lots, walkways, plazas, etc., OR, use light-colored/ high-albedo materials (reflectance of at least 0.3) for 30% of the site's non-roof impervious surfaces, OR place a minimum of 50% of parking space under-ground OR use open-grid pavement system (net impervious area of LESS than 50%) for a minimum of 50% of the parking lot area. 1
  - ☐ Use ENERGY STAR Roof compliant, high-reflectance AND low emissivity roofing (initial reflectance of at least .65 and three-year-aged reflectance of at least .5 when tested in accordance with ASTM E408) for a minimum of 75% of the roof surface; OR, install a "green" (vegetated) roof for at least 50% of the roof area. 1

Technologies /Strategies: Employ design strategies, materials, and landscaping designs that reduce heat absorption of exterior materials. Note albedo/reflectance requirements in the drawings and specifications. Provide shade (calculated on June 21, noon solar time) using native or climate tolerant trees and large shrubs, vegetated trellises, or other exterior structures supporting vegetation. Substitute vegetated surfaces for hard surfaces. Explore elimination of blacktop and the use of new coatings and integral colorants for asphalt to achieve light colored surfaces.

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## 1.0 Sustainable Sites (Continued)

### 1.C8 Light Pollution Reduction <sup>(1)</sup>

Intent: Eliminate light trespass from the building site, improve night sky access, and reduce development impact on nocturnal environments.

Requirement: ☐ Do not exceed Illuminating Engineering Society of North America (IESNA) footcandle level requirements as stated in the Recommended Practice Manual: Lighting for Exterior Environments, AND design interior and exterior lighting such that zero direct-beam illumination leaves the building site. **1**

Technologies /Strategies: Consult IESNA Recommended Practice Manual: Lighting for Exterior Environments for Commission Internationale de l'Eclairage (CIE) zone and pre and post curfew hour descriptions and associated ambient lighting level requirements. Ambient lighting for pre-curfew hours for CIE zones range between .01 footcandles for areas with dark landscapes such as parks, rural, and residential areas, and 1.5 footcandles for areas with high ambient brightness such as installation/base areas with high levels of nighttime activity. Design site lighting and select lighting styles and technologies to have a minimal impact off-site and minimal contribution to sky glow. Minimize lighting of architectural and landscape features. Exterior lighting should be consistent with security lighting requirements.

### 1.C9 Optimize Site Features

Intent: Optimize utilization of the site's existing natural features and placement of man-made features on the site.

Requirement: ☐ Perform both of the following: **1**

- Maximize the use of free site energy.
- Plan facility, parking and roadways to "fit" existing site contours and limit cut and fill.

Technologies /Strategies: Evaluate site resources to ascertain how each can enhance the proposed project and visa versa. Work to maximum advantage of the site's solar and wind attributes. Use landscaping to optimize solar and wind conditions and to contribute to energy efficiency; Locate and orient the facility on the site to optimize solar and wind conditions.

### 1.C10 Facility Impact

Intent: Minimize negative impacts on the site and on neighboring properties and structures; avoid or mitigate excessive noise, shading on green spaces, additional traffic, obscuring significant views, etc.

Requirement: ☐ Cluster facilities to reduce impact, access distance to utilities and sufficient occupant density to support mass transit. **1**

☐ Collaborate with installation/base and community planners to identify and mitigate potential impacts of the project beyond site boundaries, and transportation planners to insure efficient public transport. **1**

Technologies /Strategies: Involve local/regional planners and community members in installation/base master planning processes. Recognize the context and the impact of a project beyond site boundaries, and integrate it with the larger installation/base/community context/land use.

### 1.C11 Site Ecology

Intent: Identify and mitigate all existing site problems including contamination of soil, water, and air, as well as any negative impacts caused by noise, eyesores, or lack of vegetation, enhancing or creating new site habitat.

Requirement: ☐ Develop site environmental management and mitigation plan. **0**

Technologies /Strategies: Understand site and surrounding ecosystem interdependence and interconnectivity. Plan landscaping scheme to incorporate biodiversity. Preserve/enhance existing trees, hydrological features, ecosystems, habitats, and cultural resources. Increase the existence of healthy habitat for native species. Reintroduce native plants and trees where they have been destroyed by previous development.

<sup>(1)</sup> Adapted material not reviewed or endorsed by U. S. Green Building Council.

2.0	Water Efficiency	Score	5
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### 2.C1 Water Efficient Landscaping <sup>(2)</sup>

Intent: Limit or eliminate the use of potable water for landscape irrigation.

Requirement: ☐ Use high efficiency irrigation technology, OR, use captured rain or recycled site water to reduce potable water consumption for irrigation by 50% over conventional means. **1**

☐ Use only captured rain or recycled site water for an additional 50% reduction (100% total reduction) of potable water for site irrigation needs, OR, do not install permanent landscape irrigation systems. **1**

Technologies /Strategies: Develop a landscaping water use baseline according to the methodology outlined in the LEED Reference Guide. Specify water-efficient, native or adapted, climate tolerant plantings. High efficiency irrigation technologies include micro irrigation, moisture sensors, or weather data based controllers. Feed irrigation systems with captured rainwater, gray water, or on-site treated wastewater.

### 2.C2 Innovative Wastewater Technologies <sup>(2)</sup>

Intent: Reduce generation of wastewater and potable water demand, while increasing local aquifer recharge.

Requirement: ☐ Reduce the use of municipally provided potable water for building sewage conveyance by a minimum of 50%, OR, treat 100% of wastewater on site to tertiary standards. **0**

Technologies /Strategies: Develop a wastewater baseline according to the methodology outlined in the LEED Reference Guide. Implement decentralized on-site wastewater treatment and reuse systems. Decrease the use of potable water for sewage conveyance by utilizing gray and/or black water systems. Non-potable reuse opportunities include, toilet flushing, landscape irrigation, etc. Provide advanced wastewater treatment after use by employing innovative, ecological, on-site technologies including constructed wetlands, a mechanical recirculating sand filter, or aerobic treatment systems.

### 2.C3 Water Use Reduction <sup>(1)</sup>

Intent: Maximize water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems.

Requirement: ☐ Employ strategies that in aggregate use 20% less water than the water use baseline calculated for the building (not including irrigation) after meeting Energy Policy Act (EPACT) of 1992 fixture performance requirements. **1**

☐ Exceed the potable water use reduction by an additional 10% (30% total efficiency increase).

Technologies /Strategies: Develop a water use baseline including all water consuming fixtures, equipment, and seasonal conditions according to methodology guidance outlined in the LEED Reference Guide. Specify water conserving plumbing fixtures that exceed Energy Policy Act (EPACT) of 1992 fixture requirements in combination with ultra high efficiency or dry fixture and control technologies. Specify high water efficiency equipment (dishwashers, laundry, cooling towers, etc.). Use alternatives to potable water for sewage transport water. Use recycled or storm water for HVAC/process make up water. Install cooling tower systems designed to minimize water consumption from drift, evaporation and blowdown.

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<b>3.0</b>	<b>Energy and Atmosphere</b>	<b>Score</b>	<b>28</b>
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<b>3.R1</b>	<b><u>Fundamental Building Systems Commissioning</u> <sup>(1)</sup></b>		<b>Reqd.</b>
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Intent: Verify and ensure that fundamental building elements and systems are designed, installed and calibrated to operate as intended.

Requirement: ☐ Implement all of the following fundamental best practice commissioning procedures.

- Engage a commissioning authority.
- Develop design intent and basis of design documentation.
- Include commissioning requirements in the construction documents.
- Develop and utilize a commissioning plan.
- Verify installation, functional performance, training and documentation.
- Complete a commissioning report.

Technologies /Strategies: Introduce standards and strategies into the design process early, and then carry through selected measures by clearly stating target requirements in the construction documents. Tie contractor final payments to documented system performance. Perform additional commissioning in accordance with the DOE Building Commissioning Guide, Version 2.2. Refer to the LEED Reference Guide for detailed descriptions of required elements and references to additional commissioning guides. Specify pre-occupancy baseline IAQ testing at time of commissioning. Test for indoor air concentrations of CO, CO<sub>2</sub>, total VOCs and particulates. Test to assure that adequate ventilation rates have been achieved prior to initial occupancy.

<b>3.R2</b>	<b><u>Minimum Energy Performance</u> <sup>(1)</sup></b>		<b>Reqd.</b>
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Intent: Establish the minimum level of energy efficiency for the base building and systems.

Requirement: ☐ Design to meet building energy efficiency and performance as required by TI 800-01 (Design Criteria).

Technologies /Strategies: Use building modeling and analysis techniques to establish and document compliance. ASHRAE/IESNA 90.1-1999 provides guidance for establishing building base case development and analysis. Refer to the LEED Reference Guide for a wide variety of energy efficiency strategy resources.

Use a professionally recognized and proven computer program or programs that integrate architectural features with air-conditioning, heating, lighting, and other energy producing or consuming systems. These programs will be capable of simulating the features, systems, and thermal loads used in the design. Using established weather data files, the program will perform 8760 hourly calculations. BLAST, DOE-2 or EnergyPlus are acceptable programs for these purposes.

<b>3.R3</b>	<b><u>CFC Reduction in HVAC&amp;R Equipment</u> <sup>(2)</sup></b>		<b>Reqd.</b>
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Intent: Reduce ozone depletion.

Requirement: ☐ Zero use of CFC-based refrigerants in new base building HVAC&R systems. When reusing existing base building HVAC equipment, complete a comprehensive CFC phaseout conversion.

Technologies /Strategies: Specify only non-CFC-based refrigerants in all base building HVAC&R systems.

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## 3.0 Energy and Atmosphere (Continued)

### 3.C1 Optimize Energy Performance <sup>(1)</sup>

Intent: Achieve increasing levels of energy performance above the prerequisite standard to reduce environmental impacts associated with excessive energy use.

Requirement: ☐ Reduce design energy usage (DEU) compared to the energy use budget (EUB) in joules per square meter per year for regulated energy components as described in the requirements of Chapter 11 of the TI 800-01 (Design Criteria), as demonstrated by a whole building simulation.

6

- 1 Point will be awarded for every reduction in design energy use of 2.5% for both new and existing facilities for a maximum score of 20 points.

Regulated energy components include HVAC systems, building envelope, service hot water systems, lighting and other regulated systems as defined by ASHRAE.

Technologies /Strategies: Develop and use building modeling and analysis techniques to establish a base case that meets the minimum prerequisite standard. ASHRAE/IESNA 90.1-1999 provides guidance for establishing building base case development and analysis. Perform interactive energy use analysis for selected design elements that affect energy performance and document compliance.

Unit of measure for performance shall be annual energy usage in joules per square meter. Life-Cycle energy costs shall be determined using rates for purchased energy, such as electricity, gas, oil, propane, steam, and chilled water and approved by the adopting authority. Refer to the LEED Reference Guide or Whole Building Design Guide for a wide variety of energy efficiency resources and strategies including conservation measures, electromechanical energy efficiency technologies (for example ground-source heat pumps), passive heating and cooling strategies, solar hot water, and daylighting.

Life-Cycle costing will be done in accordance with 10 CFR 436.

Consider installation of an Energy Management and Control System (EMCS), which is compatible with exiting installation systems to optimize performance. Use sensors to control loads based on occupancy, schedule and/or the availability of natural resources use (day light or natural ventilation).

### 3.C2 Renewable Energy <sup>(1)</sup>

Intent: Encourage and recognize increasing levels of self-supply through renewable technologies to reduce environmental impacts associated with fossil fuel energy use.

Requirement: ☐ Supply a net fraction of the building's total energy use through the use of on-site renewable energy systems.

% of Total Annual Energy Usage in Renewables

5%

0

10%

0

15%

0

20%

0

Technologies /Strategies: Employ the use of on-site non-polluting-source renewable technologies contributing to the total energy requirements of the project. Consider and use high temperature solar and/or geothermal, photovoltaics, wind, biomass (other than unsustainably harvested wood), and bio-gas. Passive solar, solar hot water heating, ground-source heat pumps, and daylighting do not qualify for points under this credit. Credit for these strategies is given in Energy & Atmosphere Credit 1: Optimizing Energy Performance.

<sup>(1)</sup> Adapted material not reviewed or endorsed by U. S. Green Building Council.

## 3.0 Energy and Atmosphere (Continued)

### 3.C3 Additional Commissioning <sup>(2)</sup>

Intent: Verify and ensure that the entire building is designed, constructed, and calibrated to operate as intended.

Requirement: ☐ In addition to the Fundamental Building Commissioning prerequisite, implement the following additional commissioning tasks: 1

1. Conduct a focused review of the design prior to the construction documents phase.
2. Conduct a focused review of the construction documents when close to completion.
3. Conduct a selective review of contractor submittals of commissioned equipment.
4. Develop a system and energy management manual.
5. Have a contract in place for a near-warranty end or post occupancy review.

Items 1, 2, and 3 must be performed by someone other than the designer.

Technologies /Strategies: Introduce standards and strategies into the design process early, and then carry through selected measures by clearly stating target requirements in the construction documents. Tie contractor final payments to documented system performance. Refer to the LEED Reference Guide for detailed descriptions of required elements and references to additional guidelines.

### 3.C4 << Deleted >> <sup>(1)</sup>

### 3.C5 Measurement and Verification <sup>(1)</sup>

Intent: Provide for the ongoing accountability and optimization of building energy and water consumption performance over time.

Requirement: ☐ Comply with the installed equipment requirements for continuous metering as stated in selected Measurement and Verification Methods - Option B: Retrofit Isolation of the US DOE's International Performance Measurement and Verification Protocol (IPMVP) for the following: 1

- Lighting systems and controls.
- Constant and variable motor loads.
- Variable frequency drive (VFD) operation.
- Chiller efficiency at variable loads (kW/ton).
- Cooling load.
- Air and water economizer and heat recovery cycles.
- Air distribution static pressures and ventilation air volumes.
- Boiler efficiencies.
- Building specific process energy efficiency systems and equipment.
- Indoor water risers and outdoor irrigation systems.

Technologies /Strategies: Design and specify equipment to be installed in base building systems to allow for comparison, management, and optimization of actual vs. estimated energy and water performance. Employ building automation systems to perform M&V functions where applicable. Tie contractor final payments to documented M&V system performance and include in the commissioning report. Provide for ongoing M&V system maintenance and operating plan in building operations and maintenance manuals. Consider installation/base of an Energy Management and Control System (EMCS), which is compatible with existing installation/base systems to optimize performance.

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## 3.0 Energy and Atmosphere (Continued)

### 3.C6 Green Power <sup>(1)</sup>

Intent: Encourage the development and use of grid-source, renewable energy technologies on a net zero pollution basis.

Requirement: ☐ Engage in a two year contract to purchase the amount of power equal to projected building consumption generated from renewable sources that meet the Center for Resource Solutions (CRS) Green-E requirements. **0**

Technologies /Strategies: Purchase power from a provider that guarantees a fraction of its delivered electric power is from net nonpolluting renewable technologies. Begin by contacting local utility companies. If the project is in an open market state, investigate Green Power and Power Marketers licensed to provide power in that state. Grid power that qualifies for this credit originates from solar, wind, geothermal, biomass, or low-impact hydro sources. Low-impact hydro shall comply with the Low Impact Hydropower Certification Program.

### 3.C7 Distributed Generation

Intent: Encourage the development and use of distributed generation technologies, which are less polluting than grid-source energy.

Requirement: ☐ Reduce total energy usage and emissions by considering source energy implications and local cogeneration and direct energy conversion. Generate at least 50% of the building's projected annual consumption by on-site distributed generation sources. **0**

Technologies /Strategies: Investigate the use of integrated generation and delivery systems, such as co-generation, fuel cells, micro-turbines and off-peak thermal storage.

<sup>(1)</sup> Adapted material not reviewed or endorsed by U. S. Green Building Council.

**4.R1** **Storage & Collection of Recyclables** <sup>(1)</sup>**Reqd.**

Intent: Facilitate the reduction of waste generated by building occupants that is hauled to and disposed of in landfills.

Requirement: ☐ Provide an easily accessible area that serves the entire building that is dedicated to the separation, collection and storage of materials for recycling including (at a minimum) paper, glass, plastics, and metals.

Technologies /Strategies: Establish a waste management plan which meets requirements of the installation/base environmental and/or solid waste management plans in cooperation with users to encourage recycling. Reserve space for recycling functions early in the building occupancy programming process and show areas dedicated to collection of recycled materials on space utilization plans. Broader recycling support space considerations should allow for collection and storage of the required elements and newspaper, organic waste (food and soiled paper), and dry waste. When collection bins are used, bin(s) should be able to accommodate a 75% diversion rate and be easily accessible to custodial staff and recycling collection workers. Consider bin designs that allow for easy cleaning to avoid health issues.

**4.C1** **Building Reuse** <sup>(1)</sup>

Intent: Extend the life cycle of existing building stock, conserve resources, retain cultural resources, reduce waste, and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.

Requirement: Reuse large portions of existing structures during renovation or redevelopment projects.

- ☐ Maintain at least 75% of existing building structure and shell (exterior skin and framing excluding window assemblies). **0**
- ☐ Maintain an additional 25% (100% total) of existing building structure and shell (exterior skin and framing excluding window assemblies). **0**
- ☐ Maintain 100% of existing building structure and shell AND 50% non-shell (walls, floor coverings, and ceiling systems). **0**

Technologies /Strategies: Evaluate retention of existing structure. Consider facade preservation, particularly in installation/base areas. During programming and space planning, consider adjusting needs and occupant use patterns to fit within existing building structure and interior partition configurations. Identify and effectively address energy, structural, and indoor environmental (lead & asbestos) issues in building reuse planning and deconstruction documents. Percentage of reused non-shell building portions will be calculated as the total area (s.f.) of reused walls, floor covering, and ceiling systems, divided by the existing total area (s.f.) of walls, floor covering, and ceiling systems.

**4.C2** **Construction Waste Management** <sup>(1)</sup>

Intent: Divert construction, demolition, and land clearing debris from landfill disposal. Redirect recyclable material back to the manufacturing process.

Requirement: Develop and implement a waste management plan, quantifying material diversion by weight:

- ☐ Recycle and/or salvage at least 50% (by weight) of construction, demolition, and land clearing waste. **1**
- ☐ Recycle and/or salvage an additional 25% (75% total by weight) of the construction, demolition, and land clearing debris. **0**

Technologies /Strategies: Develop and specify a waste management plan which meets requirements of the installation/base environmental and/or solid waste management plans that identifies licensed haulers and processors of recyclables; identifies markets for salvaged materials; employs deconstruction, salvage, and recycling strategies and processes, includes waste auditing; and documents the cost for recycling, salvaging, and reusing materials. Source reduction on the job site should be an integral part of the plan.

The plan should address recycling of corrugated cardboard, metals, concrete brick, asphalt, land clearing debris (if applicable), beverage containers, clean dimensional wood, plastic, glass, gypsum board, and carpet; evaluate the cost-effectiveness of recycling rigid insulation, engineered wood products and other materials; hazardous materials storage and management; and participation in manufacturers' "take-back" programs to the maximum extent possible. Refer to the LEED Reference Guide for guidelines and references that provide waste management plan development and implementation support including model bid specifications.

<sup>(1)</sup> Adapted material not reviewed or endorsed by U. S. Green Building Council.

## 4.0 Materials and Resources (Continued)

### 4.C3 Resource Reuse <sup>(2)</sup>

Intent: Extend the life cycle of targeted building materials, reducing environmental impacts related to materials manufacturing and transport.

Requirement: ☐ Specify salvaged or refurbished materials for 5% of building materials. 1

☐ Specify salvaged or refurbished materials for 10% of building materials. 1

Technologies /Strategies: Commonly salvaged building materials include wood flooring/ paneling/cabinets, doors and frames, mantels, iron work and decorative lighting fixtures, brick, masonry and heavy timbers. See the LEED Reference Guide for calculation tools and guidelines. Determine percentages in terms of dollar value using the following steps:

1. Calculate total dollars\* (see exclusions) of the salvaged or refurbished material.
2. Calculate total dollars (see exclusions) of all building materials.
3. Divide Step 1 by Step 2 to determine the percentage.

Exclusions: In total dollar calculations, exclude; labor costs; all mechanical and electrical material and labor costs; and project overhead and fees. \*If the cost of the salvaged or refurbished material is below market value, use replacement cost to estimate the material value, otherwise use actual cost to the project.

### 4.C4 Recycled Content <sup>(1)</sup>

Intent: Increase demand for building products that have incorporated recycled content material, reducing the impacts resulting from extraction of new material.

Requirement: ☐ Specify a minimum of 25% of building materials that contain in aggregate a minimum weighted average of 20% post-consumer recycled content material, OR, a minimum weighted average of 40% post-industrial recycled content material. 1

☐ Specify an additional 25% (50% total) of building materials that contain in aggregate, a minimum weighted average of 20% post consumer recycled content material, OR, a minimum weighted average of 40% post-industrial recycled content material. 1

Technologies /Strategies: Specify building materials containing recycled content for a fraction of total building materials. Select products and materials with supporting information from the AIA Resource Guide or the EPA Environmentally Preferable Purchasing (EPP) Program. Common building materials and products with recycled content include; wall, partition, and ceiling materials and systems; insulation; tiles and carpets; cement, concrete, and reinforcing metals; structural and framing steel. For products/materials not listed, selection should be made on the basis of EPP criterion and/or:

- Toxicity;
- Embodied energy;
- Production use of water, energy and ozone depleting substances (ODSs);
- Production limits on toxic emissions and effluents;
- Minimal, reusable or recycled/recyclable packaging;
- Impact on indoor environmental quality (IEQ);
- Installation that limits generation of waste;
- Materials that limit waste generation over their life;
- EPA guideline compliance; and
- Harvested on a sustainable yield basis.

See the LEED Reference Guide for a summary of the EPA guidelines and calculation methodology guidelines. Determine percentages in terms of dollar value using the following steps:

1. Calculate total dollars (see exclusions) of the material that contain recycled content.
2. Calculate total dollars (see exclusions) of all building materials.
3. Divide Step 1 by Step 2 to determine the percentage.

Exclusions: Labor costs; all mechanical and electrical material and labor costs; project overhead and fees)

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<sup>(1)</sup> Adapted material not reviewed or endorsed by U. S. Green Building Council.

## 4.0 Materials and Resources (Continued)

### 4.C5 Local/Regional Materials <sup>(2)</sup>

Intent: Increase demand for building products that are manufactured locally, reducing the environmental impacts resulting from transportation, and supporting the local economy.

Requirement: ☐ Specify a minimum of 20% of building materials that are manufactured regionally within a radius of 500 miles. **1**

☐ Of these regionally manufactured materials, specify a minimum of 50% that are extracted, harvested, or recovered within 500 miles. **1**

Technologies /Strategies: Specify and install regionally extracted, harvested, and manufactured building materials. Contact the state and local waste management boards for information about regional building materials. See the LEED Reference Guide for calculation methodology guidelines. Determine percentages in terms of dollar value using the following steps:

1. Calculate total dollars (see exclusions) of material that is locally or regionally manufactured.
2. Calculate total dollars (see exclusions) of all building materials.
3. Divide Step 1 by Step 2 to determine the percentage.

Exclusions: Labor costs; all mechanical and electrical material and labor costs; project overhead and fees.

### 4.C6 Rapidly Renewable Materials <sup>(2)</sup>

Intent: Reduce the use and depletion of finite raw and long cycle renewable materials by replacing them with rapidly renewable materials.

Requirement: ☐ Specify rapidly renewable building materials for 5% of total building materials. **1**

Technologies /Strategies: Rapidly renewable resources are those materials that substantially replenish themselves faster than traditional extraction demand (e.g. planted and harvested in less than a 10 year cycle) and do not result in significant biodiversity loss, increase erosion, air quality impacts, and that are sustainably managed. See the LEED Reference Guide for calculation methodology guidelines. Determine percentages in terms of dollar value using the following steps:

1. Calculate total dollars (see exclusions) of materials that are considered to be rapidly renewable.
2. Calculate total dollars (see exclusions) of all building materials.
3. Divide Step 1 by Step 2 to determine the percentage.

Exclusions: Labor costs; all mechanical and electrical material and labor costs; project overhead and fees.

### 4.C7 Certified Wood <sup>(2)</sup>

Intent: Encourage environmentally responsible forest management.

Requirement: ☐ Use a minimum of 50% of wood-based materials certified in accordance with the Forest Stewardship Council guidelines for wood building components including but not limited to framing, flooring, finishes, furnishings, and non-rented temporary construction applications such as bracing, concrete form work and pedestrian barriers. **0**

Technologies /Strategies: Refer to the Forest Stewardship Council guidelines for wood building components that qualify for compliance to the requirements and incorporate into material selection for the project.

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5.0	Indoor Environmental Quality (IEQ)	Score	17
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<b>5.R1</b>	<b><u>Minimum IAQ Performance</u></b> <sup>(1)</sup>	<b>Reqd.</b>
Intent:	Establish minimum IAQ performance to prevent the development of indoor air quality problems in buildings, maintaining the health and well being of the occupants.	
Requirement:	<input type="checkbox"/> Meet the minimum requirements of voluntary consensus standard ASHRAE 62-1999, Ventilation for Acceptable Indoor Air Quality and approved Addenda.	
Technologies /Strategies:	Include proactive design details that will eliminate some of the common causes of indoor air quality problems in buildings. Introduce standards into the design process early. Incorporate references to targets in plans and specifications. Ensure ventilation system outdoor air capacity can meet standards in all modes of operation. Locate building outdoor air intakes (including operable windows) away from potential pollutants/contaminant sources such as sporulating plants (allergens), loading areas, building exhaust fans, cooling towers, sanitary vents, dumpsters, vehicular exhaust, and other sources. Include operational testing in the building commissioning report. Design cooling coil drain pans to ensure complete draining. Include measures to control and mitigate radon buildup in areas where it is prevalent. Limit humidity to a range that minimizes mold growth and promotes respiratory health.	
<b>5.R2</b>	<b><u>Environmental Tobacco Smoke (ETS) Control</u></b> <sup>(2)</sup>	<b>Reqd.</b>
Intent:	Prevent exposure of building occupants and systems to Environmental Tobacco Smoke (ETS).	
Requirement:	<input type="checkbox"/> Zero exposure of nonsmokers to ETS by prohibition of smoking in the building, OR, by providing a designated smoking room designed to effectively contain, capture and remove ETS from the building. At a minimum, the smoking room shall be directly exhausted to the outdoors with no recirculation of ETS-containing air to the non-smoking area of the building, enclosed with impermeable structural deck-to-deck partitions and operated at a negative pressure compared with the surrounding spaces of at least 7 Pa (0.03 inches of water gauge). Performance of smoking rooms shall be verified using tracer gas testing methods as described in ASHRAE Standard 129-1997. Acceptable exposure in non-smoking areas is defined as less than 1% of the tracer gas concentration in the smoking room detectable in the adjoining non-smoking areas. Smoking room testing as described in the ASHRAE Standard 129-1997 is required in the contract documents and critical smoking facility systems testing results must be included in the building commissioning plan and report or as a separate document.	
Technologies /Strategies:	Prohibit smoking in the building and/or provide designated smoking areas outside the building in locations where ETS cannot reenter the building or ventilation system and away from high building occupant or pedestrian traffic.	
<b>5.C1</b>	<b><u>IAQ Monitoring</u></b> <sup>(1)</sup>	
Intent:	Provide capacity for indoor air quality (IAQ) monitoring to sustain long term occupant health and comfort.	
Requirement:	<input type="checkbox"/> Install a permanent carbon dioxide (CO <sub>2</sub> ) monitoring system that provides feedback on space ventilation performance in a form that affords operational adjustments, AND specify initial operational set point parameters that maintain indoor carbon dioxide levels no higher than outdoor levels by more than 530 parts per million at any time.	<b>0</b>
Technologies /Strategies:	Install an independent system or make CO <sub>2</sub> monitoring a function of the building automation system. Situate monitoring locations in areas of the building with high occupant densities and at the ends of the longest runs of the distribution ductwork. Specify that system operation manuals require calibration of all of the sensors per manufacturer recommendations but not less than one year. Include sensor and system operational testing and initial set point adjustment in the commissioning plan and report. Also consider periodic monitoring of carbon monoxide (CO), total volatile organic compounds (TVOCs), and particulates (including PM10).	

<sup>(1)</sup> Adapted material not reviewed or endorsed by U. S. Green Building Council.

<sup>(1)</sup> Adapted material not reviewed or endorsed by U. S. Green Building Council.

## 5.0 Indoor Environmental Quality (IEQ) (Continued)

### 5.C2 Increase Ventilation Effectiveness <sup>(2)</sup>

Intent: Provide for the effective delivery and mixing of fresh air to building occupants to support their health, safety, and comfort.

Requirement: ☐ For mechanically ventilated buildings, design ventilation systems that result in an air change effectiveness (E) greater than or equal to 0.9 as determined by ASHRAE 129-1997. For naturally ventilated spaces demonstrate a distribution and laminar flow pattern that involves not less than 90% of the room or zone area in the direction of air flow for at least 95% of hours of occupancy. **1**

Technologies /Strategies: Employ architectural and HVAC design strategies to increase ventilation effectiveness and prevent short-circuiting of airflow delivery. Techniques available include use of displacement ventilation, low velocity, and laminar flow ventilation (under floor or near floor delivery) and natural ventilation. Operable windows with an architectural strategy for natural ventilation, cross ventilation, or stack effect can be appropriate options with study of inlet areas and locations. See the LEED Reference Guide for compliance methodology guidelines.

### 5.C3 Construction IAQ Management Plan <sup>(2)</sup>

Intent: Prevent indoor air quality problems resulting from the construction/renovation process, to sustain long term installer and occupant health and comfort.

Requirement: Develop and implement an Indoor Air Quality (IAQ) Management Plan for the construction and pre-occupancy phases of the building as follows:

☐ During construction meet or exceed the minimum requirements of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guideline for Occupied Buildings under Construction, 1995, AND protect stored on-site or installed absorptive materials from moisture damage, AND replace all filtration media immediately prior to occupancy (Filtration media shall have a Minimum Efficiency Reporting Value (MERV) of 13 as determined by ASHRAE 52.2-1999). **1**

☐ Conduct a minimum two-week building flushout with new filtration media at 100% outside air after construction ends and prior to occupancy, OR, conduct a baseline indoor air quality testing procedure consistent with current EPA protocol for Environmental Requirements, Baseline IAQ and Materials, for the Research Triangle Park Campus, Section 01445. **1**

Technologies /Strategies: Specify containment control strategies including protecting the HVAC system, controlling pollutant sources, interrupting pathways for contamination, enforcing proper housekeeping and coordinating schedules to minimize disruption. Specify the construction sequencing to install absorptive materials after the prescribed dry or cure time of wet finishes to minimize adverse impacts on indoor air quality. Materials directly exposed to moisture through precipitation, plumbing leaks, or condensation from the HVAC system are susceptible to microbial contamination. Absorptive materials to protect and sequence installation include; insulation, carpeting, ceiling tiles, and gypsum products. Appoint an IEQ Manager with owner's authority to inspect IEQ problems and require mitigation as necessary.

### 5.C4 Low-Emitting Materials <sup>(2)</sup>

Intent: Reduce the quantity of indoor air contaminants that are odorous or potentially irritating to provide installer and occupant health and comfort.

Requirement: Meet or exceed VOC limits for adhesives, sealants, paints, composite wood products, and carpet systems as follows:

☐ Adhesives must meet or exceed the VOC limits of South Coast Air Quality Management District Rule #1168 by, AND all sealants used as a filler must meet or exceed Bay Area Air Resources Board Reg. 8, Rule 51. **1**

☐ Paints and coatings must meet or exceed the VOC and chemical component limits of Green Seal requirements. **1**

☐ Carpet systems must meet or exceed the Carpet and Rug Institute Green Label Indoor Air Quality Test Program. **1**

☐ Composite wood or agrifiber products must contain no added urea-formaldehyde resins. **1**

Technologies /Strategies: Evaluate and preferentially specify materials that are low emitting, non-irritating, nontoxic and chemically inert. Request and evaluate emissions test data from manufacturers for comparative products. Ensure that VOC limits are clearly stated in specifications, in General Conditions, or in each section where adhesives, sealants, coatings, carpets, and composite woods are addressed.

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## 5.0 Indoor Environmental Quality (IEQ) (Continued)

### 5.C5 Indoor Chemical and Pollutant Source Control <sup>(1)</sup>

Intent: Avoid exposure of building occupants to potentially hazardous chemicals that adversely impact air quality.

Requirement: ☐ Design to minimize cross-contamination of regularly occupied areas by chemical pollutants: **1**

- Employ permanent entryway systems (grills, grates, etc.) to capture dirt, particulates, etc. from entering the building at all high volume entryways, AND provide areas with structural deck to deck partitions with separate outside exhausting, no air recirculation and negative pressure where chemical use occurs (including housekeeping areas and copying/print rooms), AND provide drains plumbed for appropriate disposal of liquid waste in spaces where water and chemical concentrate mixing occurs.

Technologies /Strategies: Design to physically isolate activities associated with chemical contaminants from other locations in the building, providing dedicated systems to contain and remove chemical pollutants from source emitters at source locations. Applicable measures include eliminating or isolating high hazard areas; designing all housekeeping chemical storage and mixing areas (central storage facilities and janitors closets) to allow for secure product storage; designing copy/fax/printer/printing rooms with structural deck to deck partitions and dedicated exhaust ventilation systems; and including permanent architectural entryway system(s) to catch and hold particles to keep them from entering and contaminating the building interior.

Consider utilization of EPA registered anti-microbial treatments in carpet, textile or vinyl wall coverings, ceiling tiles or paints where microbial contamination is a concern. Utilize "breathable" wall finishes where circumstances require, to reduce moisture build-up and prevent microbial contamination. Minimize selection of fibrous materials, e.g. insulation, carpet and padding and flexible fabrics, whose exposed surfaces when exposed to the air stream or occupied space can contribute significant emissions and absorb and re-emit other contaminants over time.

### 5.C6 Controllability of Systems <sup>(2)</sup>

Intent: Provide a high level of individual occupant control of thermal, ventilation, and lighting systems to support optimum health, productivity, and comfort conditions.

Requirement: ☐ Provide a minimum of one operable window and one lighting control zone per 200 s.f. for all occupied areas within 15 feet of the perimeter wall. **0**

☐ Provide controls for each individual for airflow, temperature, and lighting for 50% of the non perimeter, regularly occupied areas. **0**

Technologies /Strategies: Provide individual or integrated controls systems that control lighting, airflow, and temperature in individual rooms and/or work areas. Consider combinations of ambient and task lighting control and operable windows for perimeter and VAV systems for non perimeter with a 1:1: 2 terminal box to controller to occupant ratio.

### 5.C7 Thermal Comfort <sup>(2)</sup>

Intent: Provide for a thermally comfortable environment that supports the productive and healthy performance of the building occupants.

Requirement: ☐ Comply with ASHRAE Standard 55-1992, Addenda 1995 for thermal comfort standards including humidity control within established ranges per climate zone. **1**

☐ Install a permanent temperature and humidity monitoring system configured to provide operators control over thermal comfort performance and effectiveness of humidification and/or dehumidification systems in the building. **0**

Technologies /Strategies: Integrated envelope and HVAC system design strategies that achieve thermal comfort conditions based on mean radiant temperature, local air velocity, relative humidity, and air temperature. Install and maintain a temperature and humidity monitoring system for key areas of the building (i.e., at the perimeter, and spaces provided with humidity control). This function can be satisfied by the building automation system. Specify in system operation manuals that all sensors require quarterly calibration. Include criteria verification and system operation in commissioning plan and report.

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## 5.0 Indoor Environmental Quality (IEQ) (Continued)

### 5.C8 Daylight and Views <sup>(2)</sup>

Intent: Provide a connection between indoor spaces and the outdoor environment through the introduction of sunlight and views into the occupied areas of the building.

- Requirement: ☐ Achieve a minimum Daylight Factor of 2% (excluding all direct sunlight penetration) in 75% of all space occupied for critical visual tasks, not including copy rooms, storage areas, mechanical, laundry, and other low occupancy support areas. Exceptions include those spaces where tasks would be hindered by the use of daylight or where accomplishing the specific tasks within a space would be enhanced by the direct penetration of sunlight. **0**
- ☐ Direct line of sight to vision glazing from 90% of all regularly occupied spaces, not including copy rooms, storage areas, mechanical, laundry, and other low occupancy support areas. **0**

Technologies /Strategies: Implement design strategies to provide access to daylight and views to the outdoors in a glare-free way using exterior sun shading, interior light shelves, and /or window treatments. Orient buildings to maximize daylighting options. Consider shallow or narrow building footprints. Employ courtyards, atriums, clerestory windows, skylights, and light shelves to achieve daylight penetration (from other than direct effect or direct rays from the sun) deep into regularly occupied areas of the building.

### 5.C9 Acoustic Environment /Noise Control

Intent: Provide appropriate acoustic conditions for user privacy and comfort.

- Requirement: ☐ Minimize environmental noise through appropriate use of insulation, sound-absorbing materials and noise source isolation. **1**

Technologies /Strategies: Evaluate each occupied environment and determine the appropriate layout, materials and furnishings design.

### 5.C10 Facility In-Use IAQ Management Plan

Intent: Insure the effective management of facility air quality during its life.

- Requirement: ☐ Perform all of the following: **0**
- Develop an air quality action plan to include scheduled HVAC system cleaning.
  - Develop an air quality action plan to include education of occupants and facility managers on indoor pollutants and their roles in preventing them.
  - Develop an air quality action plan to include permanent monitoring of supply and return air, and ambient air at the fresh air intake, for carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), total volatile organic compounds (TVOCs), and particulates (including PM<sub>10</sub>).

Technologies /Strategies: Provide action plan for periodic system maintenance, monitoring, occupant/manager training.

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<b>6.0</b>	<b>Facility Delivery Process</b>	<b>Score</b>	<b>7</b>
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**6.C1      Holistic Delivery of Facility**

Intent: Encourage a facility delivery process that actively engages all stakeholders in the design process to deliver a facility that meets all functional requirements while effectively optimizing tradeoffs among sustainability, first costs, life cycle costs and mission requirements.

Requirement:	<input type="checkbox"/> Choose team leaders that are experienced in holistic delivery of facilities.	<b>1</b>
	<input type="checkbox"/> Train the entire team in the holistic delivery process. The team must include all stakeholders in the facility delivery, including the users, the contracting staff, the construction representatives, project manager, and design/engineering team members.	<b>1</b>
	<input type="checkbox"/> Identify project goals and metrics.	<b>1</b>
	<input type="checkbox"/> Plan and execute charrettes with team members at critical phases of the facility delivery.	<b>1</b>
	<input type="checkbox"/> Identify and resolve tradeoffs among sustainability, first costs, life cycle costs and mission requirements through charrettes and other collaborative processes.	<b>0</b>
	<input type="checkbox"/> Document required results for each phase of project deliverables that achieve the project goals and are measurable throughout the facility life span.	<b>0</b>

Technologies /Strategies: Develop performance specifications or choose competitive range of products that meet environmental criteria.

Use automated modeling and analysis tools to assess site and facility design alternatives.

Conduct life-cycle cost analysis (LCCA) in the design process according to the Federal Facilities Council Technical Report, Sustainable Federal Facilities: A Guide To Integrating Value Engineering, Life Cycle Costing, and Sustainable Development, FFC # 142, 2000.

Conduct a full ecological assessment to include soil quality, water resources and flows, vegetation and trees, wildlife habitats and corridors, wetlands, and ecologically sensitive areas to identify the least sensitive site areas for development. Evaluate space utilization/functions to reduce overall space requirements, considering networking, flextime, flexi-place, dual-use, and other strategies to reduce space requirements/optimize facility size.

7.0	Current Mission	Score	6
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### 7.C1 Operation and Maintenance

Intent: Encourage the development of a facility delivery process that enhances efficient operation and maintenance of the facility.

Requirement: ☐ Develop a facility operations and maintenance program to include: 0

- Commissioning instructions for all facility systems.
- Comprehensive facility operations and maintenance instructions for system operation, performance verification procedures and results, an equipment inventory, warrantee information, and recommended maintenance schedule. The instructions should include a comprehensive, preventive maintenance program to keep all facility systems functioning as designed.
- A periodic training program for occupants, facilities managers, and maintenance staff in all facility operations and maintenance activities.
- Instructions on sustainable cleaning and pest control practices.
- Develop a comprehensive site/facility recycling/waste management plan.

☐ Provide surfaces, furnishings, and equipment that are appropriately durable, according to life cycle cost analysis. 1

Technologies /Strategies: Maintain facility elements, systems and subsystems on a routine maintenance schedule to ensure integrity and longevity.

Perform scheduled cleaning and maintenance activities with nontoxic environmentally preferable cleaning products and procedures. Keep air ducts clean and free of microorganisms through a structured program of preventive maintenance. Clean lighting systems following a regular maintenance schedule to ensure optimum light output and energy efficiency.

Use pesticides and herbicides sparingly and only when necessary with preference to natural methods and materials over poisons and toxic agents.

Use automated monitors and controls for energy, water, waste, temperature, moisture, and ventilation monitors and controls. Turn off the lights, computers, computer monitors, and equipment when not in use. Enable power-down features on office equipment.

### 7.C2 Soldier and Workforce Productivity and Retention

Intent: Provide a high-quality, functional, healthy and safe work environment to promote soldier and workforce productivity and retention.

Requirement: ☐ Provide a high quality indoor environment to enhance user/occupant quality of life (QOL). 1

☐ Provide a highly functional work environment to promote user/occupant work productivity. 1

☐ Provide a healthy and safe work environment to sustain QOL and productivity. 1

Technologies /Strategies: Use a registered/certified interior designer to provide stimulating interior environments with pleasant colors, surface treatments, room proportions and ceiling heights, external views, natural lighting, and quality detailing for interior furnishings, equipment, materials and finishes. Use IES standards to provide light to occupied space with variations in level, comfortable contrasts, natural color rendition, natural/man-made, and adequate controls to optimize light aesthetic qualities. Provide occupant control of individual work areas configuration, and lighting, thermal and ventilation systems.

Collaborate with end users to identify functional and technical requirements and to perform adjacency studies. Configure occupied space to address the specific workers/occupants functions and activities that will be carried out there. Meet TI 800-01 Design Guide requirements. Design and configure occupied space, and select furniture and equipment using human ergonomics. Identify existing user amenities, such as dining, recreation, socialization, shopping and child care facilities. Identify what amenities should be incorporated into the project or provided in the future, nearby facility. Provide ventilation air in sufficient volume free from natural and man made contaminants.

<b>8.0</b>	<b>Future Missions</b>	<b>Score</b>	<b>4</b>
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### 8.C1 Functional Life of Facility and Supporting Systems

Intent: Assess the functional life of a facility and its supporting systems to optimize the infrastructure investment.

- Requirement: ☐ Identify how long the designed function is likely to occupy the current facility. **1**
- ☐ Identify how long the envelope, structure, HVAC, plumbing, communications, electrical, and other systems are likely to last before requiring replacement or upgrade. Consider economic, functional and physical obsolescence. **0**

Technologies /Strategies: Assess the typical or likely lifespan of the function(s) to be accommodated to forecast eventual adaptation to a different use(s). Assess the life spans of the various building systems/components to forecast their revision/replacement during the facility lifespan and design in a manner that facilitates revision/replacement.

Consider the life span of the weapon systems, doctrines, or other programs supported by the facility.

Use life cycle data and other sources to identify the life span of the embodied systems.

### 8.C2 Adaptation, Renewal and Future Uses

Intent: Encourage facility design that is responsive to change over time to maximize accommodation of future uses without creating waste and insuring maximum useful life of products.

- Requirement: ☐ Identify possible future uses for the facility; consider alternatives that expand the list of possible future uses. AND Design the building to accommodate as wide a range of future uses, as practical. AND Design the installation of building systems to accommodate foreseeable change with a minimum amount of disruption, cost, and additional materials. **1**
- ☐ Build the smallest facility necessary to meet current mission functional requirements, using the most efficient shape and form, while taking into consideration expansion capabilities and potential future mission requirements. AND Design the facility for recycling of materials and systems. **1**

Technologies /Strategies: Create durable, long-lasting and adaptable facility shell and structural system. Create an adaptable, flexible facility design using open planning, service corridors, interstitial space, access floors, demountable walls/partitions, modular furniture and other adaptable space configuration/utilization strategies.

Select materials that are recyclable, avoiding composite materials, such as reinforced plastics and carpet fibers and backing. Consider selecting materials and labeling construction materials with identification information to facilitate recycling. Use pre-cut/pre-fabricated materials and use standard lengths and sizes (dimensional modularity) in design. Design facility systems and subsystems for reconfiguration and/or disassembly/recycling using reversible/reusable connectors.

## Facility Points Summary

1.0 Sustainable Sites (S)		Score	17	Max 20
1.R1	<input type="checkbox"/> Erosion, Sedimentation and Water Quality Control			[Required]
1.C1	<input type="checkbox"/> Site Selection			2
1.C2	<input type="checkbox"/> Installation/Base Redevelopment			2
1.C3	<input type="checkbox"/> Brownfield Redevelopment			0
1.C4	<input type="checkbox"/> Alternative Transportation			3
1.C5	<input type="checkbox"/> Reduced Site Disturbance			2
1.C6	<input type="checkbox"/> Stormwater Management			2
1.C7	<input type="checkbox"/> Landscape and Exterior Design to Reduce Heat Islands			2
1.C8	<input type="checkbox"/> Light Pollution Reduction			1
1.C9	<input type="checkbox"/> Optimize Site Features			1
1.C10	<input type="checkbox"/> Facility Impact			2
1.C11	<input type="checkbox"/> Site Ecology			0
2.0 Water Efficiency (W)		Score	3	Max 5
2.C1	<input type="checkbox"/> Water Efficient Landscaping			2
2.C2	<input type="checkbox"/> Innovative Wastewater Technologies			0
2.C3	<input type="checkbox"/> Water Use Reduction			1
3.0 Energy and Atmosphere (E)		Score	8	Max 28
3.R1	<input type="checkbox"/> Fundamental Building Systems Commissioning			[Required]
3.R2	<input type="checkbox"/> Minimum Energy Performance			[Required]
3.R3	<input type="checkbox"/> CFC Reduction in HVAC&R Equipment			[Required]
3.C1	<input type="checkbox"/> Optimize Energy Performance			6
3.C2	<input type="checkbox"/> Renewable Energy			0
3.C3	<input type="checkbox"/> Additional Commissioning			1
3.C4	<input type="checkbox"/> <<Deleted>>			
3.C5	<input type="checkbox"/> Measurement and Verification			1
3.C6	<input type="checkbox"/> Green Power			0
3.C7	<input type="checkbox"/> Distributed Generation			0
4.0 Materials and Resources (M)		Score	8	Max 13
4.R1	<input type="checkbox"/> Storage & Collection of Recyclables			[Required]
4.C1	<input type="checkbox"/> Building Reuse			0
4.C2	<input type="checkbox"/> Construction Waste Management			1
4.C3	<input type="checkbox"/> Resource Reuse			2
4.C4	<input type="checkbox"/> Recycled Content			2
4.C5	<input type="checkbox"/> Local/Regional Materials			2
4.C6	<input type="checkbox"/> Rapidly Renewable Materials			1
4.C7	<input type="checkbox"/> Certified Wood			0
5.0 Indoor Environmental Quality (IEQ) [Q]		Score	10	Max 17
5.R1	<input type="checkbox"/> Minimum IAQ Performance			[Required]
5.R2	<input type="checkbox"/> Environmental Tobacco Smoke (ETS) Control			[Required]
5.C1	<input type="checkbox"/> IAQ Monitoring			0
5.C2	<input type="checkbox"/> Increase Ventilation Effectiveness			1
5.C3	<input type="checkbox"/> Construction IAQ Management Plan			2
5.C4	<input type="checkbox"/> Low-Emitting Materials			4
5.C5	<input type="checkbox"/> Indoor Chemical and Pollutant Source Control			1
5.C6	<input type="checkbox"/> Controllability of Systems			0
5.C7	<input type="checkbox"/> Thermal Comfort			1
5.C8	<input type="checkbox"/> Daylight and Views			0
5.C9	<input type="checkbox"/> Acoustic Environment /Noise Control			1
5.C10	<input type="checkbox"/> Facility In-Use IAQ Management Plan			0

Facility Points Summary (Continued)			Maximum Points
<b>6.0</b>	<b>Facility Delivery Process (P)</b>	<b>Score</b>	<b>4</b>
			<b>Max 7</b>
6.C1	<input type="checkbox"/> Holistic Delivery of Facility		4
<b>7.0</b>	<b>Current Mission</b>	<b>Score</b>	<b>4</b>
			<b>Max 6</b>
7.C1	<input type="checkbox"/> Operation and Maintenance		1
7.C2	<input type="checkbox"/> Soldier and Workforce Productivity and Retention		3
<b>8.0</b>	<b>Future Missions</b>	<b>Score</b>	<b>3</b>
			<b>Max 4</b>
8.C1	<input type="checkbox"/> Functional Life of Facility and Supporting Systems		1
8.C2	<input type="checkbox"/> Adaptation, Renewal and Future Uses		2
<b>Total Score</b>		<b>57</b>	<b>Max 100</b>

SPiRiT Sustainable Project Certification Levels		
SPiRiT Bronze		25 to 34 Points
SPiRiT Silver		35 to 49 Points
SPiRiT Gold	57	50 to 74 Points
SPiRiT Platinum		75 to 100 Points

[illegible]

# SPiRiT Comment Sheet

Please forward any comments that you may have on this Sustainable Project Rating Tool, preferably by Email, to:

Mr. Harry Goradia  
U. S. Army Corps of Engineers  
ATTN: CEMP-ET  
441 G Street NW  
Washington, DC 20314  
Phone (202) 761-7170, FAX (202) 761-0633  
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SPiRiT Para.This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

## SECTION TABLE OF CONTENTS

## DIVISION 01 - GENERAL REQUIREMENTS

## SECTION 01335

## SUSTAINABLE DESIGN AND DEVELOPMENT

## PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 DESCRIPTION
- 1.3 SUBMITTALS
- 1.4 DOCUMENTATION REQUIREMENTS
  - 1.4.1 SPiRiT credit 1.C5 Reduced Site Disturbance
  - 1.4.2 SPiRiT credit 3.R1 Fundamental Building System Commissioning
  - 1.4.3 SPiRiT credit 4.C2 Construction Waste Management
  - 1.4.4 SPiRiT credit 4.C3 Resource Reuse
  - 1.4.5 SPiRiT credit 4.C4 Recycled Content
  - 1.4.6 SPiRiT credit 4.C5 Local/Regional Materials
  - 1.4.7 SPiRiT credit 4.C6 Rapidly Renewable Materials
  - 1.4.8 SPiRiT credit 5.C3 Construction IAQ Management Plan
    - 1.4.8.1 Baseline IAQ Testing Requirements

## PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION

## 3.1 GENERAL

-- End of Section Table of Contents --

## SECTION 01335

## SUSTAINABLE DESIGN AND DEVELOPMENT

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## U.S. GREEN BUILDING COUNCIL

LEED (Leadership in Energy and Environmental Design) Reference Guide, Version 2.1  
Version 2.0

## U.S. GOVERNMENT

ETL 1110-3-491 Sustainable Design for Military Facilities

SPiRiT 1.4.1 Sustainable Project Rating Tool  
<http://www.usace.army.mil/inet/usace-docs/eng-tech-ltrs/etl1110-3-491/a-c.pdf>

## 1.2 DESCRIPTION

This project has been designed for, and shall be developed for a sustainable rating of gold in accordance with SPiRiT 1.4.1 . Sustainable Project Rating Tool (SPiRiT) identifies the SPiRiT credit items that are designed into or otherwise required for this project. No variations or substitutions to the SPiRiT credits identified for this contract shall be allowed without written consent from the Contracting Officer. Should there be a case where there is any problem meeting the full requirements of a SPiRiT credit identified for this project in Sustainable Project Rating Tool (SPiRiT) , the Contractor must bring this to the attention of the Contracting Officer immediately.

The Contractor shall provide and assemble under separate cover documentation verifying compliance with SPiRiT requirements as listed in this specification and as otherwise identified within the Technical Specifications. Some SPiRiT credits are inherent in the design provided and require no further submittal or documentation. For these credits, the Contractor shall familiarize himself with the project features that relate to them so that no action contrary to the design intent is inadvertently taken during construction. Some SPiRiT credits involve material selection and are generally identified within the Technical Specification with the notation "SDD", though not specifically identified in all occurrences. Some SPiRiT credits are dependent on construction practices.

All SPiRiT credits identified in Sustainable Project Rating Tool (SPiRiT) under the columns "Material Selection" and "Construction Practices" shall be documented by the Contractor. Sustainable Project Rating Tool (SPiRiT)

provides a general summary of types of action, submittals required and specification references. Detailed documentation on submittal requirements is contained in the Technical Specifications and paragraph 1.4 below. Some of the SPiRiT points may have common traits between items inherent in the design and those involving material selection or construction practices. In this case, the Contractor shall only document those items pertaining to material selection or construction practices.

In all cases where a material, product or execution requirement is identified as a sustainable feature ("SDD") elsewhere in the contract documents, additional data or certificates shall be submitted with the individual component or process validating the material or component to the respective SPiRiT credit item. This additional data or certificates shall be separable from the other submitted data and a copy shall be included in the SPiRiT Documentation Notebook in addition to the distribution indicated in the submittal register.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-01 Preconstruction Submittals

SPiRiT Compliance Plan;

A detailed plan identifying all construction practices, procurement data or cumulative calculations of components required for SPiRiT credit that must be identified and tracked during the course of construction. Plan shall indicate the SPiRiT credit being tracked or documented, individual components of the SPiRiT credit related items, dates of submittal of individual components of the SPiRiT credit related items, and proposed method of tracking in accordance with SPiRiT 1.4.1 and the LEED Reference Guide.

#### SD-05 Design Data

SPiRiT Calculations;

Calculations showing compliance with a required SPiRiT credit where identified in Sustainable Project Rating Tool (SPiRiT) or within the SPiRiT Compliance Plan. Calculations shall be current and available for review monthly. Final calculations should be included in the SPiRiT Documentation Notebook under the appropriate tab.

#### SD-11 Closeout Submittals

SPiRiT Documentation Notebook;

The Contractor shall prepare a comprehensive notebook documenting compliance for each SPiRiT credit identified in Sustainable Project Rating Tool (SPiRiT) . Notebook shall include product

data for material selection where "SDD" is indicated, final calculations, certifications for construction practices, procurement data, cumulative calculations of components of materials throughout the project, and other items as identified in the SPiRiT Compliance Plan. Notebook must contain all required data to support full compliance with the indicated SPiRiT credit. SPiRiT credits that are indicated as inherent to the design will be documented by the designer of record.

SPiRiT Documentation Notebooks shall be formatted to match SPiRiT numbering system and tabbed for each point. Notebooks shall be kept current on a weekly basis and at least one set shall be available on the jobsite at all times. If the Contractor fails to maintain the SPiRiT Documentation Notebooks as specified herein, the Contracting Officer will deduct from the monthly progress payment an amount representing the estimated cost of maintaining these Notebooks. This monthly deduction will continue until an agreement can be reached between the Contracting Officer and the Contractor regarding the accuracy and completeness of the Notebooks.

The original and one copy of each notebook shall be submitted at project closeout.

#### 1.4 DOCUMENTATION REQUIREMENTS

SPiRiT credits as identified in Sustainable Project Rating Tool (SPiRiT) shall be incorporated and documented as required by the Technical Specifications and in full compliance with the SPiRiT 1.4.1 and the LEED Reference Guide. SPiRiT Credits not identified elsewhere in the Technical Specifications, or those requiring further instruction are listed below.

##### 1.4.1 SPiRiT credit 1.C5 Reduced Site Disturbance

Limits of disturbance and/or site restoration requirements are identified in the Contract Documents. The Contractor shall identify in his SPiRiT Compliance Plan controls that will be put in place to ensure compliance with the identified limits.

##### 1.4.2 SPiRiT credit 3.R1 Fundamental Building System Commissioning

Individual component commissioning requirements are specified in the Technical Specifications where required. The Contractor shall group all reports and results of commissioning into this requirement for Building Systems Commissioning. Refer to the SPiRiT 1.4.1, Sustainable Rating Tool and the LEED Reference Guide.

##### 1.4.3 SPiRiT credit 4.C2 Construction Waste Management

Notwithstanding the requirements of Section 01572 CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT, the Contractor shall include in his SPiRiT Compliance Plan a waste management plan that complies with the requirements of SPiRiT credit 4.C2 to the point level listed in Sustainable Project Rating Tool (SPiRiT) for recycling and/or salvage of at least 50 percent (by weight) of construction, demolition and land clearing waste. The plan should include proposed worksheets for tracking the value used and record keeping requirements for documentation to validate the final value. Refer to SPiRiT 1.4.1, Sustainable Rating Tool and the LEED Reference Guide

for definitions and requirements.

#### 1.4.4 SPiRiT credit 4.C3 Resource Reuse

The Contractor shall include in his SPiRiT Compliance Plan a Resource Reuse plan that complies with the requirements of SPiRiT credit 4.C3 to the point level listed in Sustainable Project Rating Tool (SPiRiT) for utilizing a minimum of 5 percent salvaged or refurbished materials (by dollar value) in the construction of this project. An additional 5 percent (10 percent total by dollar value) requirement on the use of salvaged or refurbished materials (by dollar value) in the construction of this project is required to gain the second point in this credit. The plan should include proposed worksheets for tracking the value used and record keeping requirements for documentation to validate the final value. Refer to the SPiRiT 1.4.1 and the LEED Reference Guide for definitions, exclusions and requirements.

#### 1.4.5 SPiRiT credit 4.C4 Recycled Content

Notwithstanding the requirements of Section 01670 RECYCLED/RECOVERED MATERIALS promoting the use of recycled or recovered materials, the Contractor shall include in his SPiRiT Compliance Plan a method of tracking, record keeping and validation that a minimum of 25 percent (by dollar value) of building materials that contain in aggregate a minimum weighted average of 20 percent post-consumer recycled content material OR a minimum weighted average of 40 percent post-industrial recycled content material is used within this project. An additional 25 percent (50 percent total by dollar value) of building materials that contain in aggregate a minimum weighted average of 20 percent post-consumer recycled content material, OR, a minimum weighted average of 40 percent post-industrial recycled content material is required to gain the second point in this credit. The plan should include proposed worksheets for tracking the value used and record keeping requirements for documentation to validate the final value. Recycled content worksheet at [http://en.sas.usace.army.mil/ae/spreadsheet/4\\_C4%20Recycle%20Content%20Worksheet.xls](http://en.sas.usace.army.mil/ae/spreadsheet/4_C4%20Recycle%20Content%20Worksheet.xls) may be used. Refer to the SPiRiT 1.4.1 and the LEED Reference Guide for definitions, exclusions and requirements.

#### 1.4.6 SPiRiT credit 4.C5 Local/Regional Materials

The Contractor shall include in his SPiRiT Compliance Plan a method of tracking, record keeping and validation that a minimum of 20 percent (by dollar value) of building products are manufactured regionally within a radius of 500 miles from the project site. Of these regionally manufactured materials, a minimum of 50 percent shall have been extracted, harvested or recovered within 500 miles. The plan should include proposed worksheets for tracking the value used and record keeping requirements for documentation to validate the final value. Regional Material worksheet at <http://en.sas.usace.army.mil> "Engineering Criteria" may be used. Refer to the SPiRiT 1.4.1 and the LEED Reference Guide for definitions, exclusions and requirements.

#### 1.4.7 SPiRiT credit 4.C6 Rapidly Renewable Materials

The Contractor shall include in his SPiRiT Compliance Plan a method of tracking, record keeping and validation that a minimum of 5 percent (by dollar value) of building products come from rapidly renewable resources. The plan should include proposed worksheets for tracking the value used and

record keeping requirements for documentation to validate the final value. Certified Wood worksheet at <http://en.sas.usace.army.mil> "Engineering Criteria" may be used. Refer to the SPiRiT 1.4.1 and the LEED Reference Guide for definitions, exclusions and requirements.

#### 1.4.8 SPiRiT credit 5.C3 Construction IAQ Management Plan

The Contractor shall included in his SPiRiT Compliance Plan a Construction Indoor Air Quality (IAQ) Management Plan for the construction and pre-occupancy phases of the building that, during construction, meets or exceeds the minimum requirements of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guideline for Occupied Buildings under Construction, 1995, AND protects stored on-site or installed absorptive materials from moisture damage, AND replaces all filtration media immediately prior to occupancy Additionally, the plan shall provide for a minimum 2-week building flushout period with new filtration media at 100 percent outside air after construction ends and prior to occupancy, OR, at Contractor's option, conducting baseline indoor air quality testing in accordance with paragraph 1.4.9.1, "Baseline IAQ Testing Requirements", with testing done in six different locations. Refer to the SPiRiT 1.4.1 and the LEED Reference Guide for definitions and requirements.

##### 1.4.8.1 Baseline IAQ Testing Requirements

A. HVAC System Verification: To assure compliance with recognized standards for indoor air quality including ASHRAE Standard 62-1989 or latest version, the Contractor's independent testing and balancing agency shall verify the performance of each HVAC system including space temperature and space humidity uniformity, outside air quantity, filter installation, drain pan operation and any obvious contamination sources.

B. Indoor Air Quality Testing: Upon verification of HVAC system operation, the Contractor shall hire an independent Contractor, subject to the approval by the Contracting Officer's Representative, with a minimum of 5 years' experience in performing the types of testing specified herein, to test levels of indoor air contaminants for compliance with specified requirements.

1. A test plan shall be submitted for approval of the Contracting Officer's Representative. The plan shall specify procedures, times, instrumentation and sampling methods that will be employed.

2. Contaminant levels shall be measured in areas agreed upon by the Contractor and the Contracting Officer's Representative. Areas with very high outside air ventilation rates such as laboratories are excluded from these testing requirements. The Contracting Officer's Representative is the sole judge of areas exempt from testing.

3. Collect air samples on three consecutive days during normal business hours (between the hours of 8:00 am and 5:00 pm) with building operating at normal HVAC rates. Average the results of

each three-day test cycle to determine compliance or non-compliance of indoor air quality for each air handling zone tested.

4. Sample and record outside air levels of formaldehyde and TVOC contaminants at outside air intake of each respective air handling unit simultaneously with indoor tests to establish basis of comparison for these contaminant levels. Indoor testing will be done in the breathing zone; between 4 feet and 7 feet from the floor.

5. Acceptance of respective portions of buildings by the Government is subject to compliance with specified limits of indoor air quality contaminant levels.

C. Compliance: Indoor air quality shall conform to the following standards and limits:

1. Carbon Monoxide: Not to exceed 9 ppm.
2. Carbon Dioxide: Not to exceed 800 ppm.
3. Airborne Mold and Mildew: Simultaneous indoor and outdoor readings.
4. Maximum Air Concentration Standards: Indoor room air concentration levels, emission rates and qualities of the listed contaminants shall not exceed the limits specified in Maximum Indoor Air Concentration Standards Table below.

D. Test Reports: Prepare test reports showing the results and location of each test, a summary of the HVAC operating conditions, a listing of any discrepancies and recommendations for corrective actions, if required.

1. Include certification of test equipment calibration with each test report.

E. If any test fails the standard, the Contractor is responsible to ventilate the building with 100 percent outside air until the building passes both air quality tests and duct inspections. Retesting shall be performed at no expense to the Government.

#### MAXIMUM INDOOR AIR CONCENTRATION STANDARDS TABLE

<u>Indoor Contaminants</u>	<u>Allowable Air Concentration Levels*</u>
Formaldehyde	<20 micrograms per cubic meter**
Total Volatile Organic Compound (TVOC)	< 200 micrograms per cubic meter**
4-Phenylcyclohexene (4~PC)***	<3 micrograms per cubic meter
Total Particulates (PM)	< 20 micrograms per cubic meter
Regulated Pollutants	<NAAQS

\* All levels must be achieved prior to acceptance of the building.

\*\* Above outside air concentrations.

\*\*\* 4-phenylcyclohexene is an odorous contaminant constituent in carpets with styrene-butadienelatex rubber (SBR).

## MAXIMUM INDOOR AIR CONCENTRATION STANDARDS TABLE

<u>Indoor Contaminants</u>	<u>Allowable Air Concentration Levels*</u>
PART 2    PRODUCTS (NOT USED)	

PART 3    EXECUTION

3.1    GENERAL

SPiRiT credits as identified in Sustainable Project Rating Tool (SPiRiT) below are contract requirements and shall be incorporated in full compliance with the SPiRiT 1.4.1 and the LEED Reference Guide.

-- End of Section --

percent in masonry cement mortar.

## 2.5 MASONRY MORTAR

Mortar Type S shall conform to the proportion specification of ASTM C 270 except Type S cement-lime mortar proportions shall be 1 part cement, 1/2 part lime and 4-1/2 parts aggregate. Type S mortar shall be used for for all CMU work. Pointing mortar in showers and kitchens shall contain ammonium stearate, or aluminum tri-stearate, or calcium stearate in an amount equal to 3 percent by weight of cement used. Cement shall have a low alkali content and be of one brand. Aggregates shall be from one source.

### 2.5.1 Admixtures for Masonry Mortar

In cold weather, a non-chloride based accelerating admixture may be used subject to approval. Accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C 494/C 494M, Type C.

### 2.5.2 Colored Mortar

Mortar coloring shall be added to the mortar used for exposed masonry surfaces to produce a uniform color . Quantity of pigment to cementitious content of the masonry cement shall not exceed 5 by weight; carbon black shall not exceed 1 percent by weight. Quantity of pigment to cementitious content of cement-lime mix shall not exceed 10 percent by weight, carbon black no more than 2 percent by weight. Mortar coloring shall be chemically inert, of finely ground limeproof pigment, and furnished in accurately pre-measured and packaged units that can be added to a measured amount of cement. Compressive strength of colored mortar shall equal 1800 psi.

### 2.5.3 Cement

Portland cement shall conform to ASTM C 150, Type I, . Masonry cement shall conform to ASTM C 91, Type S . Containers shall bear complete instructions for proportioning and mixing to obtain the required types of mortar.

### 2.5.4 Pre-Mixed Mortar

### 2.5.5 Sand and Water

Pre-mixed mortar shall conform to ASTM C 1142, Type RS Sand shall conform to ASTM C 144. ~~Water shall be clean, potable, and free from substances which could adversely affect the mortar.~~ Water, for the purpose of mixing mortar for the CMU walls, shall be provided by the Government. The contractor shall be responsible for transporting the reverse osmosis water from the RO Water Plant, Building (No. P-44) to the site. RO water will minimize the efflorescence from occurring on the CMU walls. The cost of transporting the RO water shall be borne by the Contractor. The container used to transport the RO water shall be free of leakage and capped to prevent spillage. It shall be constructed in such a manner to prevent the introduction of foreign substances and other deleterious materials that may adversely affect the mortar.

## 2.6 WATER-REPELLANT ADMIXTURE

Polymeric type formulated to reduce porosity and water transmission. Construct panels of masonry units conforming to ASTM C 744 and mortar which contain the water-repellant admixture. When tested in accordance with ASTM C 1072, such panels shall have flexural strength not less than that specified or indicated. When tested in accordance with ASTM E 514, panels shall exhibit no water visible on back of test panel and no leaks through the panel after 24 hours, and not more than 25 percent of wall area shall be damp after 72 hours.

between partitions and structural or exterior walls as shown.

### 3.3 WEEP HOLES

Wherever through-wall flashing occurs, provide weep holes to drain flashing to exterior. Weep holes shall be provided not more than 24 inches on centers in mortar joints of the exterior wythe above wall flashing, over foundations, bond beams, and any other horizontal interruptions of the cavity. Weep holes shall be formed by placing short lengths of well-greased No. 10, 5/16 inch nominal diameter, braided cotton sash cord in the mortar and withdrawing the cords after the wall has been completed. Other approved methods may be used for providing weep holes. Weep holes shall be kept free of mortar and other obstructions.

### 3.4 MORTAR

Mortar shall be mixed in a mechanically operated mortar mixer for at least 3 minutes, but not more than 5 minutes. Measurement of ingredients for mortar shall be by volume. Ingredients not in containers, such as sand, shall be accurately measured by the use of measuring boxes.

Water used in the mortar for the CMU walls shall be RO water. See 2.5.5

Sand and Water. Water shall be mixed with the dry ingredients in sufficient amount to provide a workable mixture which will adhere to the vertical surfaces of masonry units. Mortar that has stiffened because of loss of water through evaporation shall be retempered by adding water to restore the proper consistency and workability. Mortar that has reached its initial set or that has not been used within 2-1/2 hours after mixing shall be discarded.

### 3.5 REINFORCING STEEL

Reinforcement shall be cleaned of loose, flaky rust, scale, grease, mortar, grout, or other coating which might destroy or reduce its bond prior to placing grout.

Bars with kinks or bends not shown on the drawings shall not be used.

Reinforcement shall be placed prior to grouting. Unless otherwise indicated, vertical wall reinforcement shall extend to within 2 inches of tops of walls.

#### 3.5.1 Positioning Bars

Vertical bars shall be accurately placed within the cells at the positions indicated on the drawings. A minimum clearance of 1/2 inch shall be maintained between the bars and masonry units. Minimum clearance between parallel bars shall be one diameter of the reinforcement. Vertical reinforcing may be held in place using bar positioners located near the ends of each bar and at intermediate intervals of not more than 192 diameters of the reinforcement. Column and pilaster ties shall be wired in position around the vertical steel. Ties shall be in contact with the vertical reinforcement and shall not be placed in horizontal bed joints.

#### 3.5.2 Splices

Bars shall be lapped a minimum of 48 diameters of the reinforcement. Welded or mechanical connections shall develop at least 125 percent of the specified yield strength of the reinforcement.

### 3.6 PLACING GROUT

Cells containing reinforcing bars shall be filled with grout. Hollow masonry units in walls or partitions supporting plumbing, heating, or other mechanical fixtures, voids at door and window jambs, and other indicated

#### 1.3.1 Delivery and Storage

Materials shall be delivered to the jobsite in the manufacturer's original unopened packages, clearly marked with the manufacturer's name, brand name, description of contents, and label for compliance with UL requirements. Time limited materials shall be used before shelf life expires. Materials other than ballast shall be stored in clean, dry areas. Storage temperatures shall be as specified by the manufacturer. A maximum of one day's supply of materials other than ballast may be stored on the roof when distributed so as not to exceed the roof live load limit. These materials shall be kept dry and clean until application. Ballast shall be stored uncovered, shall not be in contact with sod or earth, and shall not be stored on the roof.

#### 1.3.2 Fire Resistance

The roofing system fire resistance shall be rated Class A as determined by UL 790 or Class 1 as determined by FM P7825a. Compliance of each component of the roofing system shall be evidenced by label or by written certification from the manufacturer.

#### 1.3.3 Wind Uplift Requirements

Wind uplift resistance of the complete roof assembly shall be rated Class I-90 in accordance with FM P9513 or Class 90 in accordance with UL 580.

#### 1.3.4 Energy Star Roof Compliance

***Energy Star Roof shall be provided as a part of sustainable design requirements. Energy Star Roof shall be high-reflectance and low emissivity roofing with initial reflectance of at least 0.65 and three-year-aged reflectance of at least 0.5 when tested in accordance with ASTM E408 for a minimum of 75% of the roof surface.***

#### 1.3.5 Warranty

Manufacturer's standard warranty for 20 years shall be furnished. Warranty shall provide for repair or replacement of the complete roofing system, including insulation and flashings, if leaking is caused by defects in materials or workmanship.

#### 1.3.6 Qualifications

The Contractor shall submit documentation verifying that the Contractor has a minimum of 2 years experience with PVC roofing systems and has been certified by the PVC roofing manufacturer as an approved Installer for the specified PVC roofing system.

### PART 2 PRODUCTS

#### 2.1 SOLVENTS AND SEALANTS

Adhesives, welding solvents, and sealants shall be as recommended by the membrane manufacturer.

#### 2.2 FASTENERS

Fasteners for sheet-metal flashing shall be corrosion-resistant steel annular-ring type nails, or screws. Fasteners for anchoring the roofing membrane shall be as approved by the membrane manufacturer and identical to those used to obtain the wind uplift rating.

#### 2.3 FLASHINGS

Flashings shall be ultra-violet resistant materials furnished by the membrane manufacturer, except as otherwise specified. Shaped flashing components shall be prefabricated. Sheared edges of metal flashings that

### 2.2.2 Mirrors, Glass (MG)

Glass for mirrors shall be Type I transparent flat type, Class 1-clear. Glazing Quality q1 1/4 inch thick conforming to ASTM C 1036. Glass shall be coated on one surface with silver coating, copper protective coating, and mirror backing paint. Silver coating shall be highly adhesive pure silver coating of a thickness which shall provide reflectivity of 83 percent or more of incident light when viewed through 1/4 inch thick glass, and shall be free of pinholes or other defects. Copper protective coating shall be pure bright reflective copper, homogeneous without sludge, pinholes or other defects, and shall be of proper thickness to prevent "adhesion pull" by mirror backing paint. Mirror backing paint shall consist of two coats of special scratch and abrasion-resistant paint and shall be baked in uniform thickness to provide a protection for silver and copper coatings which will permit normal cutting and edge fabrication.

### 2.2.3 Combination Paper Towel Dispenser/Waste Receptacle Units (PTDWR)

Dispenser/receptacle shall be recessed and shall have a capacity of 600 sheets of C-fold, single-fold, or quarter-fold towel. Waste receptacle shall be designed to be locked in unit and removable for service. Locking mechanism shall be tumbler key lock. Waste receptacle shall have a capacity of 18 gallons. Unit shall be fabricated of not less than 0.30 inch stainless steel welded construction with all exposed surfaces having a satin finish. Waste receptacle that accepts reusable liner standard for unit manufacturer shall be provided.

### 2.2.4 Sanitary Napkin Disposer (SND)

Sanitary napkin disposal shall be constructed of Type 304 stainless steel with removable leak-proof receptacle for disposable liners. Fifty disposable liners of the type standard with the manufacturer shall be provided. Receptacle shall be retained in cabinet by tumbler lock. Disposer shall be provided with a door for inserting disposed napkins, and shall be surface mounted.

### 2.2.10 Sanitary Napkin and Tampon Dispenser (SNTD)

*Sanitary napkin and tampon dispenser shall be recessed]. Dispenser, including door shall be Type 304 stainless steel and shall dispense both napkins and tampons with a minimum capacity of 20 each. Dispensing mechanism shall be for coin operation. Coin mechanisms shall have minimum denominations of free. Doors shall be hung with a full-length corrosion-resistant steel piano hinge and secured with a tumbler lock. Keys for coin box shall be different from the door keys.*

### 2.2.5 2.2.13 Soap Dispenser (SD)

Soap dispenser shall be lavatory mounted, liquid type consisting of a polyethylene tank with a minimum 32 fluid ounces holding capacity and a 6 inch spout length.

### 2.2.6 Toilet Tissue Dispenser (TTD)

Toilet tissue holder shall be Type II - surface mounted with two rolls of standard tissue stacked vertically. Cabinet shall be stainless steel, satin finish.

## 3.5.3 Maximum Length for Anchor Braces

Type	Size (Inches)	Maximum Length* (Feet/Inches)
Angles	1-1/2 x 1-1/2 x 1/4	4-10
	2 x 2 x 1/4	6-6
	2-1/2 x 1-1/2 x 1/4	8-0
	3 x 2-1/2 x 1/4	8-10
	3 x 3 x 1/4	9-10
Rods	3/4	3-1
	7/8	3-8
Flat Bars	1-1/2 x 1/4	1-2
	2 x 1/4	1-2
	2 x 3/8	1-9
Pipes (40S)	1	7-0
	1-1/4	9-0
	1-1/2	10-4
	2	13-1

## 3.5.4 Bolts

Bolts used for attachment of anchors to pipe and structure shall be not less than 1/2 inch diameter.

## 3.6 EQUIPMENT SWAY BRACING

## 3.6.1 Suspended Equipment and Light Fixtures

Equipment sway bracing shall be provided for items supported from overhead floor or roof structural systems, including light fixtures. Braces shall consist of angles, rods, wire rope, bars, or pipes arranged as shown and secured at both ends with not less than 1/2 inch bolts. Sufficient braces shall be provided for equipment to resist a horizontal force as specified in ~~Chapter 10 of TI 809-04~~ IBC 2000 without exceeding safe working stress of bracing components. The Contractor shall provide, for approval, specific force calculations in accordance with IBC 2000 for the equipment in the project. Details of equipment bracing shall be submitted for acceptance. In lieu of bracing with vertical supports, these items may be supported with hangers inclined at 45 degrees directed up and radially away from equipment and oriented symmetrically in 90-degree intervals on the horizontal plane, bisecting the angles of each corner of the equipment, provided that supporting members are properly sized to support operating weight of equipment when hangers are inclined at a 45-degree angle.

## 3.6.2 Floor or Pad Mounted Equipment

## 3.6.2.1 Shear Resistance

Floor mounted equipment shall be bolted to the floor. Requirements for the number and installation of bolts to resist shear forces shall be in accordance with paragraph ANCHOR BOLTS.

## SECTION TABLE OF CONTENTS

## DIVISION 15 - MECHANICAL

## SECTION 15951

## DIRECT DIGITAL CONTROL FOR HVAC AND OTHER LOCAL BUILDING SYSTEMS

## PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 DEFINITIONS
- 1.3 SYSTEM DESCRIPTION
  - 1.3.1 System Requirements
  - 1.3.2 Verification of Dimensions
  - 1.3.3 Drawings
- 1.4 SUBMITTALS
- 1.5 PROJECT SEQUENCING
- 1.6 QUALITY CONTROL (QC) CHECKLISTS
- 1.7 DELIVERY AND STORAGE
- 1.8 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS
- 1.9 MAINTENANCE AND SERVICE
  - 1.9.1 Description of Work
  - 1.9.2 Personnel
  - 1.9.3 Scheduled Inspections
  - 1.9.4 Scheduled Work
  - 1.9.5 Emergency Service
  - 1.9.6 Operation
  - 1.9.7 Records and Logs
  - 1.9.8 Work Requests
  - 1.9.9 System Modifications
- 1.10 SURGE PROTECTION
  - 1.10.1 Power-Line Surge Protection
  - 1.10.2 Surge Protection for Transmitter and Control Wiring
- 1.11 INPUT MEASUREMENT ACCURACY
- 1.12 BUILDING CONTROL NETWORK
  - 1.12.1 Backbone Media
  - 1.12.2 Control Network Requirements

## PART 2 PRODUCTS

- 2.1 GENERAL EQUIPMENT REQUIREMENTS
  - 2.1.1 Operation Environment Requirements
- 2.2 ENCLOSURES AND WEATHERSHIELDS
  - 2.2.1 Enclosures
  - 2.2.2 Weathershields
- 2.3 TUBING
  - 2.3.1 Copper
  - 2.3.2 Stainless Steel
  - 2.3.3 Plastic
- 2.4 NETWORK HARDWARE
  - 2.4.1 ANSI/EIA 709.1B Network Hardware
    - 2.4.1.1 ANSI/EIA 709.1B Routers
    - 2.4.1.2 ANSI/EIA 709.3 Repeaters

- 2.4.1.3 Gateways
- 2.5 WIRE AND CABLE
  - 2.5.1 Terminal Blocks
  - 2.5.2 Control Wiring for Binary Signals
  - 2.5.3 Wiring for 120-Volt Circuits
  - 2.5.4 Control Wiring for Analog Signals
  - 2.5.5 Transformers
- 2.6 AUTOMATIC CONTROL VALVES
  - 2.6.1 Ball Valves
  - 2.6.2 Butterfly Valves
  - 2.6.3 Two-Way Valves
  - 2.6.4 Three-Way Valves
  - 2.6.5 Duct-Coil and Terminal-Unit-Coil Valves
  - 2.6.6 Valves for Chilled-Water, Condenser-Water, and Glycol Service
  - 2.6.7 Valves for High-Temperature Hot-Water, Hot-Water and Dual Temperature Service
  - 2.6.8 Valves for Steam Service
- 2.7 DAMPERS
  - 2.7.1 Damper Assembly
  - 2.7.2 Operating Linkages
  - 2.7.3 Damper Types
    - 2.7.3.1 Flow Control Dampers
    - 2.7.3.2 Mechanical Rooms and Other Utility Space Ventilation Dampers
    - 2.7.3.3 Smoke Dampers
- 2.8 SENSORS AND INSTRUMENTATION
  - 2.8.1 Transmitters
  - 2.8.2 Temperature Sensors
    - 2.8.2.1 Sensor Ranges and Accuracy
    - 2.8.2.2 Point Temperature Sensors
    - 2.8.2.3 Averaging Temperature Sensors
    - 2.8.2.4 Thermowells
  - 2.8.3 Relative Humidity Sensor
  - 2.8.4 Carbon Dioxide (CO<sub>2</sub>) Sensors
  - 2.8.5 Differential Pressure Instrumentation
    - 2.8.5.1 Differential Pressure Sensors
    - 2.8.5.2 Differential Pressure Switch
  - 2.8.6 Flow Sensors
    - 2.8.6.1 Airflow Measurement Array (AFMA)
    - 2.8.6.2 Orifice Plate
    - 2.8.6.3 Flow Nozzle
    - 2.8.6.4 Venturi Tube
    - 2.8.6.5 Annular Pitot Tube
    - 2.8.6.6 Insertion Turbine Flowmeter
    - 2.8.6.7 Vortex Shedding Flowmeter
    - 2.8.6.8 Positive Displacement Flow Meter
    - 2.8.6.9 Flow Meters, Paddle Type
    - 2.8.6.10 Flow Switch
    - 2.8.6.11 Gas Utility Flow Meter
  - 2.8.7 Electrical Instruments
    - 2.8.7.1 Watt or Watthour Transducers
    - 2.8.7.2 Watthour Revenue Meter (with and without Demand Register)
    - 2.8.7.3 Current Transducers
    - 2.8.7.4 Current Sensing Relays (CSRs)
    - 2.8.7.5 Voltage Transducers
  - 2.8.8 pH Sensor
  - 2.8.9 Oxygen Analyzer
  - 2.8.10 Vibration Switch
  - 2.8.11 Conductivity Sensor
  - 2.8.12 NO<sub>x</sub> Monitor

- 2.8.13 Floor Mounted Leak Detector
- 2.8.14 Temperature Switch
  - 2.8.14.1 Duct Mount Temperature Low Limit Safety Switch (Freezestat)
  - 2.8.14.2 Pipe Mount Temperature Limit Switch (Aquistat)
- 2.8.15 Damper End Switches
- 2.9 INDICATING DEVICES
  - 2.9.1 Thermometers
    - 2.9.1.1 Piping System Thermometers
    - 2.9.1.2 Air-Duct Thermometers
  - 2.9.2 Pressure Gauges
  - 2.9.3 Low Differential Pressure Gauges
- 2.10 OUTPUT DEVICES
  - 2.10.1 Actuators
    - 2.10.1.1 Valve Actuators
    - 2.10.1.2 Damper Actuators
    - 2.10.1.3 Positive Positioners
  - 2.10.2 Solenoid-Operated Electric to Pneumatic Switch (EPS)
  - 2.10.3 Electric to Pneumatic Transducers (EP)
  - 2.10.4 Relays
- 2.11 USER INPUT DEVICES
- 2.12 MULTIFUNCTION DEVICES
  - 2.12.1 Current Sensing Relay Command Switch
  - 2.12.2 Thermostats
- 2.13 DIRECT DIGITAL CONTROL (DDC) HARDWARE
  - 2.13.1 General Requirements
  - 2.13.2 Hardware Input-Output (I/O) Functions
  - 2.13.3 Application Specific Controller (ASC)
    - 2.13.3.1 Local Display Panel (LDP)
  - 2.13.4 General Purpose Programmable Controller (GPPC)

### PART 3 EXECUTION

- 3.1 EXISTING CONDITIONS SURVEY
- 3.2 CONTROL SYSTEM INSTALLATION
  - 3.2.1 General Installation Requirements
    - 3.2.1.1 HVAC Control System
    - 3.2.1.2 Device Mounting Criteria
    - 3.2.1.3 Labels and Tags
  - 3.2.2 DDC Hardware
  - 3.2.3 Local Display Panel (LDP)
  - 3.2.4 Gateways
  - 3.2.5 Network Interface Jack
  - 3.2.6 Room Instrument Mounting
  - 3.2.7 Indication Devices Installed in Piping and Liquid Systems
  - 3.2.8 Duct Smoke Detectors
  - 3.2.9 Occupancy Sensors
  - 3.2.10 Temperature Limit Switch
  - 3.2.11 Averaging Temperature Sensing Elements
  - 3.2.12 Air Flow Measurement Arrays (AFMA)
  - 3.2.13 Duct Static Pressure Sensors
  - 3.2.14 Relative Humidity Sensors
  - 3.2.15 Flowmeters
  - 3.2.16 Dampers
    - 3.2.16.1 Damper Actuators
    - 3.2.16.2 Damper Installation
  - 3.2.17 Valves
    - 3.2.17.1 Ball Valves
    - 3.2.17.2 Butterfly Valves
  - 3.2.18 Local Gauges for Actuators

- 3.2.19 Wire and Cable
- 3.2.20 Copper Tubing
- 3.2.21 Plastic Tubing
- 3.2.22 Pneumatic Lines
  - 3.2.22.1 Pneumatic Lines in Mechanical/Electrical Spaces
  - 3.2.22.2 Pneumatic Lines External to Mechanical/Electrical Spaces
  - 3.2.22.3 Terminal Single Lines
  - 3.2.22.4 Connection to Liquid and Steam Lines
  - 3.2.22.5 Connection to Ductwork
  - 3.2.22.6 Tubing in Concrete
  - 3.2.22.7 Tubing Connection to Actuators
- 3.3 DRAWINGS AND CALCULATIONS
  - 3.3.1 Network Bandwidth Usage Calculations
  - 3.3.2 DDC Contractor Design Drawings
  - 3.3.3 Draft As-Built Drawings
  - 3.3.4 Final As-Built Drawings
- 3.4 HVAC SYSTEMS SEQUENCES OF OPERATION
  - 3.4.1 Alarm Handling
  - 3.4.2 Scheduling
    - 3.4.2.1 System Mode
    - 3.4.2.2 System Scheduler Requirements
    - 3.4.2.3 System Scheduler Output Determination
    - 3.4.2.4 Air Handler System Scheduling
    - 3.4.2.5 Stand-Alone Terminal Unit Scheduling
  - 3.4.3 Sequences of Operation for Air Handling Units
    - 3.4.3.1 Variable Air Volume System with Return Fan
  - 3.4.4 Sequences of Operation for Terminal Units
    - 3.4.4.1 Zone Temperature Control - Cooling-Only VAV Box
    - 3.4.4.2 Zone Temperature Control - VAV Box with Reheat
  - 3.4.5 Sequences of Operation for Hydronic Systems
    - 3.4.5.1 Hydronic Heating Hot Water From Single-Building Boiler
- 3.5 CONTROLLER TUNING
- 3.6 START-UP AND START-UP TEST
- 3.7 PERFORMANCE VERIFICATION TEST (PVT)
  - 3.7.1 PVT Procedures
  - 3.7.2 PVT Execution
  - 3.7.3 PVT Report
- 3.8 TRAINING
  - 3.8.1 Training Documentation
  - 3.8.2 Training Course Content

-- End of Section Table of Contents --

## SECTION 15951

## DIRECT DIGITAL CONTROL FOR HVAC AND OTHER LOCAL BUILDING SYSTEMS

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 500-D (1998) Laboratory Methods of Testing  
Dampers for Rating

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/ASME B16.34 (1996) Valves - Flanged, Threaded, and  
Welding End

ANSI/ASME B16.15 (1994) Cast Bronze Threaded Fittings,  
Classes 125 and 250

ANSI C12.1 (1995) Code for Electricity Metering

ANSI C12.10 (1997) Electromechanical Watthour Meters

ANSI C12.20 (2002) Electricity Meter - 0.2 and 0.5  
Accuracy Classes

ANSI/EIA 709.1B (2002) Control Network Protocol  
Specification

ANSI/EIA 709.3 (1998) Free-Topology Twisted-Pair Channel  
Specification

ANSI/FCI 70-2 (2003) Control Valve Seat Leakage

ANSI/EIA 852 (2001) Tunneling Component Network  
Protocols Over Internet Protocol Channels

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING  
ENGINEERS (ASHRAE)

ASHRAE Fundamentals Hdbk (2001) Fundamentals Handbook

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 269 (1996) Seamless and Welded Austenitic  
Stainless Steel Tubing for General Service

ASTM B 88 (1996) Seamless Copper Water Tube

ASTM B 88M (1996) Seamless Copper Water Tube (Metric)

ASTM D 1693 (1997a) Environmental Stress-Cracking of Ethylene Plastics

ASTM D 635 (1997) Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position

## ASME INTERNATIONAL (ASME)

ASME B40.1 (1991) Gauges - Pressure Indicating Dial Type - Elastic Element

ASME BPVC SEC VIII D1 (1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

## FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 15 (2002) FCC Rules and Regulations Part 15: Radio Frequency Devices (Volume II)

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41 (1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits

IEEE Std 142 (1991) IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems

## INSTRUMENT SOCIETY OF AMERICA (ISA)

ISA S7.0.01 (1996) Quality Standard for Instrument Air

## LONMARK INTERNATIONAL (LonMark)

LonMark Interoperability Guide (2002) LonMark Application-Layer Interoperability Guide; Version 3.3

LonMark SNVT Master List (2002) LonMark SNVT Master List; Version 11, Revision 2

LonMark XIF Guide (2001) LonMark External Interface File Reference Guide; Revision 4.0B

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (2003) Enclosures for Electrical Equipment (1000 Volts Maximum)

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

NFPA 90A (1996) Installation of Air Conditioning and Ventilating Systems

## UNDERWRITERS LABORATORIES (UL)

UL 1585	(2001) Class 2 and Class 3 Transformers
UL 555	(1995) Standard for Fire Dampers
UL 555S	(1996; R2000) Leakage Rated Dampers for Use in Smoke Control Systems
UL 94	(1996; Rev thru Jul 1998) Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 916	(2004) Energy Management Equipment

## 1.2 DEFINITIONS

The following list of definitions may contain terms not found elsewhere in the Section but are included here for completeness.

- a. Application Specific Controller: A device that is furnished with a pre-established built in application that is configurable but not re-programmable. An ASC has a fixed factory-installed application program (i.e Program ID) with configurable settings.
- b. Binary: A two-state system where an "ON" condition is represented by a high signal level and an "OFF" condition is represented by a low signal level. 'Digital' is sometimes used interchangeably with 'binary'.
- c. Binding: The act of establishing communications between ANSI/EIA 709.1B devices by associating the output of a device to the input of another.
- d. Building Control Network: The ANSI/EIA 709.1B control network installed under Section 15951 DIRECT DIGITAL CONTROL FOR HVAC AND OTHER LOCAL BUILDING SYSTEMS consisting of a backbone and one or more local control busses.
- e. Building Point of Connection (BPOC): The BPOC is the point of connection between the UMCS network backbone (an IP network) and the building control network backbone. The hardware at this location, that provides the connection is referred to as the BPOC Hardware. In general, the term "BPOC Location" means the place where this connection occurs, and "BPOC Hardware" means the device that provides the connection. Sometimes the term "BPOC" is used to mean either and its actual meaning (i.e. location or hardware) is determined by the context in which it is used.
- f. Channel: A portion of the control network consisting of one or more segments connected by repeaters. Channels are separated by routers. The device quantity limitation is dependent on the topology/media and device type. For example, a TP/FT-10 network with locally powered devices is limited to 128 devices per channel.
- g. Configuration Parameter: Controller setting usually written to EEPROM. Also see 'Standard Configuration Parameter Type (SCPT)'
- h. Control Logic Diagram: A graphical representation of control logic for multiple processes that make up a system.

- i. Domain: A grouping of up to 32,385 nodes that can communicate directly with each other. (Devices in different domains cannot communicate directly with each other.) Part of the Node Addressing scheme.
- j. Explicit Messaging: A method of communication between devices where each message contains a message code that identifies the type of message and the devices use these codes to determine the action to take when the message is received. These messages are non-standard and often vendor (application) dependent.
- k. External Interface File (XIF): A file which documents a device's external interface, specifically the number and types of LonMark objects; the number, types, directions, and connection attributes of network variables; and the number of message tags.
- l. Functional Profile: The description of one or more LonMark Objects used to classify and certify devices.
- m. Gateway: A device that translates from one protocol to another. Gateways are also called Communications Bridges or Protocol Translators.
- n. General Purpose Programmable Controller (GPPC): Unlike an ASC, a GPPC is not furnished with a fixed application program. A GPPC can be (re-)programmed, usually using vendor-supplied software.
- o. LonMark Object: A collection of network variables, configuration parameters, and associated behavior defined by LonMark International and described by a Functional Profile. Defines how information is exchanged between devices on a network (inputs from and outputs to the network).
- p. LNS Plug-in: Software which runs in an LNS compatible software tool. Device configuration plug-ins provide a 'user friendly' interface to configuration parameters.
- q. LonMark: See LonMark International. Also, a certification issued by LonMark International to ANSI/EIA 709.1B devices.
- r. LonMark International: Standards committee consisting of numerous independent product developers and systems integrators dedicated to determining and maintaining the interoperability guidelines for the LonWorks industry. Maintains guidelines for the interoperability of ANSI/EIA 709.1B devices and issues the LonMark Certification for ANSI/EIA 709.1B devices.
- s. LonMark Interoperability Association: See 'LonMark International'.
- t. LonWorks: The overall communications technology, developed by Echelon Corporation, for control systems. The term is often used to refer to the technology in general, and may include reference to any/all of the: protocol, network management, and interoperability guidelines where the technology is based on the ANSI/EIA 709.1B protocol and employs interoperable devices along with the capability to openly manage these devices (via multiple vendors) using a network configuration (or service) tool.
- u. LonWorks Network Services (LNS): A network management and database

standard for ANSI/EIA 709.1B devices.

v. Monitoring and Control (M&C) Software: The UMCS 'front end' software which performs supervisory functions such as alarm handling, scheduling and data logging and provides a user interface for monitoring the system and configuring these functions.

w. Network Variable: See 'Standard Network Variable Type (SNVT)'.

x. Network Configuration Tool: The software used to configure the control network and set device configuration properties. This software creates and modifies the control network database (LNS Database).

y. Node: A device that communicates using the ANSI/EIA 709.1B protocol and is connected to an ANSI/EIA 709.1B network.

z. Node Address: The logical address of a node on the network. Variations in node addressing are possible, but the 'Domain, Subnet, Node' format is the established standard for this specification.

aa. Node ID: A unique 48-bit identifier assigned (at the factory) to each ANSI/EIA 709.1B device. Sometimes called the Neuron ID.

bb. Program ID. An identifier (number) stored in the device (usually EEPROM) that identifies the node manufacturer, functionality of device (application & sequence), transceiver used, and the intended device usage.

cc. Repeater: A device that connects two control network segments and retransmits all information received on one side onto the other.

dd. Router: A device that connects two channels and controls traffic between the channels by retransmitting signals received from one subnet onto the other based on the signal destination. Routers are used to subdivide a control network and to control bandwidth usage.

ee. Segment: A 'single' section of a control network that contains no repeaters or routers. The device quantity limitation is dependent on the topology/media and device type. For example, a TP/FT-10 network with locally powered devices is limited to 64 devices per segment.

ff. Service Pin: A hardware push-button on a device which causes the device to broadcast a message (over the control network) containing its Node ID and Program ID. This broadcast can also be initiated via software.

gg. Standard Configuration Parameter Type (SCPT): Pronounced 'skip-it'. A standard format type (maintained by LonMark International) for Configuration Parameters.

hh. Standard Network Variable Type (SNVT): Pronounced 'snivet'. A standard format type (maintained by LonMark International) used to define data information transmitted and received by the individual nodes. The term SNVT is used in two ways. Technically it is the acronym for Standard Network Variable Type, and is sometimes used in this manner. However, it is often used to indicate the network variable itself (i.e. it can mean "a network variable of a standard network variable type"). In general, the intended meaning should be clear from the context.

ii. Subnet: Consists of a logical (not physical) grouping of up to 127 nodes, where the logical grouping is defined by node addressing. Part of the Node Addressing scheme.

jj. TP/FT-10: A Free Topology Twisted Pair network defined by ANSI/EIA 709.3. This is the most common media type for an ANSI-709.1 control network.

kk. UMCS Network: An IP network connecting multiple building level control networks using the ANSI/EIA 852 standard.

ll. User-defined Configuration Parameter Type (UCPT): Pronounced 'u-keep-it'. A Configuration Parameter format type that is defined by the device manufacturer.

mm. User-defined Network Variable Type (UNVT): A network variable format defined by the device manufacturer. Note that UNVTs create non-standard communications (other vendor's devices may not correctly interpret it) and may close the system and therefore are not permitted by this specification.

### 1.3 SYSTEM DESCRIPTION

The Direct Digital Control (DDC) system shall be a complete system suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as specified and shown.

#### 1.3.1 System Requirements

Systems installed under this guide specification shall have the following characteristics:.

a. The control system shall be an open implementation of LonWorks technology using ANSI/EIA 709.1B as the communications protocol and using LonMark Standard Network Variable Types as defined in LonMark SNVT Master List for communication over the network.

b. LonWorks Network Services (LNS) shall be used for all network management including addressing and binding of network variables. A copy of the LNS database shall be submitted to the project site as specified.

c. The hardware shall perform the control sequences as specified and shown to provide control of the equipment as specified and shown.

d. Control sequence logic shall reside in DDC hardware in the building. The building control network shall not be dependent upon connection to a Utility Monitoring and Control System (UMCS) for performance of control sequences in this specification. The hardware shall, to the greatest extent practical, perform the sequences without reliance on the building network.

e. The hardware shall be installed such that individual control equipment can be replaced by similar control equipment from other equipment manufacturers with no loss of system functionality.

f. All necessary documentation, configuration information, configuration tools, programs, drivers, and other software shall be

licensed to and otherwise remain with the Government such that the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor.

g. The Contractor shall provide sufficient documentation and data, including rights to documentation and data, such that the Government or their agents can execute work to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor.

h. Hardware shall be installed and configured such that the Government or their agents are able to perform repair, replacement, and upgrades of individual hardware without further interaction with the Contractor.

i. Control hardware shall be installed and configured to provide all input and output Standard Network Variables (SNVTs) as shown and as needed to meet the requirements of this specification.

j. All DDC devices installed under this specification shall communicate via ANSI/EIA 709.1B. The control system shall be installed such that a SNVT output from any node on the network can be bound to any other node in the domain.

#### 1.3.2 Verification of Dimensions

After becoming familiar with all details of the work, the Contractor shall verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

#### 1.3.3 Drawings

The Government will not indicate all offsets, fittings, and accessories that may be required on the drawings. The Contractor shall carefully investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, shall arrange such work accordingly, and shall provide all work necessary to meet such conditions.

#### 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.

Technical data packages consisting of technical data and computer software (meaning technical data which relates to computer software) which are specifically identified in this project and which may be defined/required in other specifications shall be delivered strictly in accordance with the CONTRACT CLAUSES and in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered shall be identified by reference to the particular specification paragraph against which it is furnished. All submittals not specified as technical data packages are considered 'shop drawings' under the Federal Acquisition Regulation Supplement (FARS) and shall contain no proprietary information and be delivered with unrestricted

rights.

The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES, the CONTRACT CLAUSES and DD Form 1423 and according to the sequencing specified in paragraph PROJECT SEQUENCING:

SD-02 Shop Drawings

DDC Contractor Design Drawings; G, AO

DDC Contractor Design Drawings shall be submitted in hard copy and on CDROM in AutoCAD format.

Draft As-Built Drawings; G, AO

Draft As-Built Drawings shall be submitted in hard copy and on CDROM in AutoCAD format.

Final As-Built Drawings; G, AO

Final As-Built Drawings shall be submitted in hard copy and on CDROM in AutoCAD format.

SD-03 Product Data

Manufacturer's Catalog Data; G, AO

Product specific catalog cuts shall be submitted for each product provided under this specification.

Programming Software; G, AO

The most recent version of the Programming software for each type (manufacturer and model) of General Purpose Programmable Controller (GPPC) shall be submitted as a Technical Data Package and shall be licensed to the project site. Software shall be submitted on CD-ROM and 3 hard copies of the software user manual shall be submitted for each piece of software provided.

GPPC Application Programs; G, AO

All installed GPPC Application Programs shall be submitted on CD-ROM as a Technical Data Package. The CD-ROM shall include a list or table of contents clearly indicating which application program is associated with each device. 2 copies of the GPPC Application Program's CD-ROM shall be submitted.

XIF files; G, AO

External interface files (XIF files) shall be submitted as a technical data package for each model of DDC Hardware provided under this specification. XIF files shall be submitted on CD-ROM.

LNS Database; G, AO

Two copies of the LNS Database for the complete control network provided under this specification shall be submitted as a Technical Data Package. Each copy shall be on CD-ROM and shall be clearly marked identifying it as the LNS Database for the work

covered under this specification and with the date of the most recent database modification.

LNS Plug-in; G, AO

LNS Plug-ins for each Application Specific Controller shall be submitted as a Technical Data Package. LNS Plug-ins distributed under a license shall be licensed to the project site. Plug-ins shall be submitted on CD-ROM. Hard copy manuals, if available, shall be submitted for each plug-in provided.

#### SD-05 Design Data

Network Bandwidth Usage Calculations; G, AO

Four copies of the Network Bandwidth Usage Calculations shall be submitted.

#### SD-06 Test Reports

Existing Conditions Report; G, AO

Four copies of the Existing Conditions Report shall be submitted.

Start-Up and Start-Up Testing Report; G, AO

Four copies of the Start-Up and Start-Up Testing Report shall be submitted. The Start-Up and Testing report may be submitted as a Technical Data Package.

PVT Procedures; G, AO

Four copies of the PVT Procedures shall be submitted. The PVT Procedures may be submitted as a Technical Data Package.

PVT Report; G, AO

Four copies of the PVT Phase Report shall be submitted. The PVT Phase Report may be submitted as a Technical Data Package.

Pre-Construction QC Checklist; G, AO

Four copies of the Pre-Construction QC Checklist shall be submitted.

Post-Construction QC Checklist; G, AO

Four copies of the Post-Construction QC Checklist shall be submitted.

#### SD-10 Operation and Maintenance Data

Operation and Maintenance (O&M) Instructions; G, AO

2 copies of the Operation and Maintenance Instructions, indexed and in booklet form shall be submitted. The Operation and Maintenance Instructions shall be a single volume or in separate volumes, and may be submitted as a Technical Data Package.

## Training Documentation; G, AO

Training manuals shall be delivered for each trainee on the Course Attendee List with 2 additional copies delivered for archival at the project site. 2 copies of the Course Attendee List shall be delivered with the archival copies. The Training Documentation may be submitted as a Technical Data Package.

## SD-11 Closeout Submittals

## Closeout QC Checklist; G, AO

Four copies of the Closeout QC Checklist shall be submitted.

## 1.5 PROJECT SEQUENCING

TABLE I: PROJECT SEQUENCING specifies the sequencing of submittals as specified in paragraph SUBMITTALS (denoted by an 'S' in the 'TYPE' column) and activities as specified in PART 3: EXECUTION (denoted by an 'E' in the 'TYPE' column).

a. Sequencing for submittals: The sequencing specified for submittals is the deadline by which the submittal shall be initially submitted to the Government. Following submission there will be a Government review period as specified in Section 01330 SUBMITTAL PROCEDURES. If the submittal is not accepted by the Government, the Contractor shall revise the submittal and resubmit it to the Government within 14 days of notification that the submittal has been rejected. Upon resubmittal there shall be an additional Government review period. If the submittal is not accepted the process repeats until the submittal is accepted by the Government.

b. Sequencing for Activities: The sequencing specified for activities indicates the earliest the activity may begin.

c. Abbreviations: In TABLE I the abbreviation AAO is used for 'after approval of' and 'ACO' is used for 'after completion of'.

TABLE I. PROJECT SEQUENCING

ITEM #	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY or DEADLINE FOR SUBMITTAL)
1	S	Existing Conditions Report	
2	S	DDC Contractor Design Drawings	
3	S	Manufacturer's Catalog Data	
4	S	Network Bandwidth Usage Calculations	
5	S	Pre-construction QC Checklist	
6	E	Install Building Control System	AAO #1 thru #5
7	E	Start-Up and Start-Up Testing	ACO #6
8	S	Post-Construction QC Checklist	7 days ACO #7
9	S	Programming Software	7 days ACO #7
10	S	XIF Files	7 days ACO #7
11	S	LNS Plug-ins	7 days ACO #7
12	S	Start-Up and Start-Up Testing Report	7 days ACO #7

TABLE I. PROJECT SEQUENCING

ITEM #	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY or DEADLINE FOR SUBMITTAL)	
			-----	
13	S	Draft As-Built Drawings	7	days ACO #7
14	S	PVT Procedures	7	days before scheduled start of #15 and AAO #12
15	E	PVT	AAO #13 and #14	
16	S	PVT Report	7	days ACO #15
17	S	GPPC Application Programs	7	days AAO #16
18	S	LNS Database	7	days AAO #16
19	S	Final As-Built Drawings	14	days AAO #16
20	S	O&M Instructions	AAO #19	
21	S	Training Documentation	AAO #12 and 14	days before scheduled start of #22
22	E	Training	AAO #20 and #21	
23	S	Closeout QC Checklist	ACO #22	

#### 1.6 QUALITY CONTROL (QC) CHECKLISTS

The Contractor's Chief Quality Control (QC) Representative shall complete the QC Checklist in APPENDIX A and submit a Pre-Construction QC Checklist, Post-Construction QC Checklist and a Closeout QC Checklist as specified. The QC Representative shall verify each item in the Checklist and initial in the provided area to indicate that the requirement has been met. The QC Representative shall sign and date the Checklist prior to submission to the Government.

#### 1.7 DELIVERY AND STORAGE

Products shall be stored with protection from the weather, humidity, and temperature variations, dirt and dust, and other contaminants, within the storage condition limits published by the equipment manufacturer.

#### 1.8 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

The HVAC control System Operation and Maintenance Instructions shall include:

- a. "Manufacturer Data Package 3" as specified in Section 01781 OPERATION AND MAINTENANCE DATA for each piece of control equipment.
- b. "Manufacturer Data Package 4" as described in Section 01781 for all air compressors.
- c. HVAC control system sequences of operation formatted as specified.
- d. Procedures for the HVAC system start-up, operation and shut-down including the manufacturer's supplied procedures for each piece of equipment, and procedures for the overall HVAC system.
- e. As-built HVAC control system detail drawings formatted as specified.
- f. Printouts of configuration settings for all devices.
- g. Routine maintenance checklist. The routine maintenance checklist

shall be arranged in a columnar format. The first column shall list all installed devices, the second column shall state the maintenance activity or state no maintenance required, the third column shall state the frequency of the maintenance activity, and the fourth column for additional comments or reference.

h. Qualified service organization list.

i. Start-Up and Start-Up Testing Report.

j. Performance Verification Test (PVT) Procedures and Report.

#### 1.9 MAINTENANCE AND SERVICE

Services, materials and equipment shall be provided as necessary to maintain the entire system in an operational state as specified for a period of one year after successful completion and acceptance of the Performance Verification Test. Impacts on facility operations shall be minimized.

##### 1.9.1 Description of Work

The adjustment and repair of the system shall include the manufacturer's required sensor and actuator (including transducer) calibration, span and range adjustment.

##### 1.9.2 Personnel

Service personnel shall be qualified to accomplish work promptly and satisfactorily. The Government shall be advised in writing of the name of the designated service representative, and of any changes in personnel.

##### 1.9.3 Scheduled Inspections

Two inspections shall be performed at six-month intervals and all work required shall be performed. Inspections shall be scheduled in June and December. These inspections shall include:

a. Visual checks and operational tests of equipment.

b. Fan checks and filter changes for control system equipment.

c. Clean control system equipment including interior and exterior surfaces.

d. Check and calibrate each field device. Check and calibrate 50 percent of the total analog inputs and outputs during the first inspection. Check and calibrate the remaining 50 percent of the analog inputs and outputs during the second major inspection. Certify analog test instrumentation accuracy to be twice the specified accuracy of the device being calibrated. Randomly check at least 25 percent of all digital inputs and outputs for proper operation during the first inspection. Randomly check at least 25 percent of the remaining digital inputs and outputs during the second inspection.

e. Run system software diagnostics and correct diagnosed problems.

f. Resolve any previous outstanding problems.

#### 1.9.4 Scheduled Work

This work shall be performed during regular working hours, Monday through Friday, excluding Federal holidays.

#### 1.9.5 Emergency Service

The Government will initiate service calls when the system is not functioning properly. Qualified personnel shall be available to provide service to the system. A telephone number where the service supervisor can be reached at all times shall be provided. Service personnel shall be at the site within 24 hours after receiving a request for service. The control system shall be restored to proper operating condition as required per Section 01780A CLOSEOUT SUBMITTALS.

#### 1.9.6 Operation

Scheduled adjustments and repairs shall include verification of the control system operation as demonstrated by the applicable tests of the performance verification test.

#### 1.9.7 Records and Logs

Dated records and logs shall be kept of each task, with cumulative records for each major component, and for the complete system chronologically. A continuous log shall be maintained for all devices. The log shall contain initial analog span and zero calibration values and digital points. Complete logs shall be kept and shall be available for inspection onsite, demonstrating that planned and systematic adjustments and repairs have been accomplished for the control system.

#### 1.9.8 Work Requests

Each service call request shall be recorded as received and shall include its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion. A record of the work performed shall be submitted within 5 days after work is accomplished.

#### 1.9.9 System Modifications

Recommendations for system modification shall be submitted in writing. No system modifications, including operating parameters and control settings, shall be made without prior approval of the Government. Any modifications made to the system shall be incorporated into the Operations and Maintenance Instructions, and other documentation affected.

#### 1.10 SURGE PROTECTION

##### 1.10.1 Power-Line Surge Protection

Equipment connected to ac circuits shall be protected against or withstand power-line surges. Equipment protection shall meet the requirements of IEEE C62.41. Fuses shall not be used for surge protection.

##### 1.10.2 Surge Protection for Transmitter and Control Wiring

DDC hardware shall be protected against or withstand surges induced on

control and transmitter wiring installed outdoors and as shown. The equipment protection shall be protected against the following two waveforms:

- a. A waveform with a 10-microsecond rise time, a 1,000-microsecond decay time and a peak current of 60 amps.
- b. A waveform with an 8-microsecond rise time, a 20-microsecond decay time and a peak current of 500 amperes.

#### 1.11 INPUT MEASUREMENT ACCURACY

Sensors, transmitters and DDC Hardware shall be selected, installed and configured such that the maximum error of the measured value at the SNVT output of the DDC hardware is less than 150% of the maximum allowable error specified for the sensor or instrumentation.

#### 1.12 BUILDING CONTROL NETWORK

The building control network shall consist of a backbone and one or more local control busses as specified.

##### 1.12.1 Backbone Media

The backbone shall be a TP/FT-10 network in accordance with ANSI/EIA 709.3 or an IP network as specified in Section 13801 UTILITY MONITORING AND CONTROL SYSTEMS according to the following criteria:

- a. The backbone shall be an IP network as specified in Section 13801 if both of the following conditions are met:

- (1) the Network Bandwidth Calculations for a heavily loaded network show that more than 70% of the 78 kbps (kilobits per second) bandwidth is used or the Network Bandwidth Calculations for a normally loaded network show that more than 30% of the 78 kbps bandwidth is used.

- (2) the Government has approved the Network Bandwidth Calculations submittal.

- b. The backbone shall be a TP/FT-10 network otherwise.

##### 1.12.2 Control Network Requirements

The control network shall meet the following requirements:

- a. The backbone shall have no control devices connected to it. Only ANSI/EIA 709.1B Routers and ANSI/EIA 709.1B TP/FT-10 to IP Routers may be connected to the backbone. ANSI/EIA 709.1B TP/FT-10 to IP Routers are specified in Section 13801 UTILITY MONITORING AND CONTROL SYSTEMS
- b. The backbone shall be installed such that a router at the Building Point of Connection (BPOC) location [as shown] [\_\_\_\_] may be connected to the backbone.
- c. The local control bus shall use ANSI/EIA 709.1B over a TP/FT-10 network in doubly-terminated bus topology in accordance with ANSI/EIA 709.3

d. The local control busses shall be installed such that no node (device connected to the control network) has more than two ANSI/EIA 709.1B Routers and ANSI/EIA 709.3 Repeaters (in any combination) between it and the backbone, including the router connected to the backbone.

e. All DDC Hardware shall connect to a local control bus.

f. All DDC Hardware shall be locally powered; link power is not acceptable.

## PART 2 PRODUCTS

PART 2 of this specification covers requirements for Products (equipment). Installation requirements for these products are covered in PART 3 of this specification.

### 2.1 GENERAL EQUIPMENT REQUIREMENTS

Units of the same type of equipment shall be products of a single manufacturer. Each major component of equipment shall have the manufacturer's name and address, and the model and serial number in a conspicuous place. Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of these and similar products. The standard products shall have been in a satisfactory commercial or industrial use for two years prior to use on this project. The two year use shall include applications of equipment and materials under similar circumstances and of similar size. DDC Hardware not meeting the two-year field service requirement shall be acceptable provided it has been successfully used by the Contractor in a minimum of two previous projects. The equipment items shall be supported by a service organization. Items of the same type and purpose shall be identical, including equipment, assemblies, parts and components. Manufacturer's catalog data sheets documenting compliance with product specifications shall be submitted as specified for each product installed under this specification.

#### 2.1.1 Operation Environment Requirements

All products shall be rated for continuous operation under the following conditions:

a. Pressure: Pressure conditions normally encountered in the installed location.

b. Vibration: Vibration conditions normally encountered in the installed location.

c. Temperature:

(1) Products installed indoors: Ambient temperatures in the range of 0 to 50 degreesC (32 to 112 degreesF) and temperature conditions outside this range normally encountered at the installed location.

(2) Products installed outdoors or in unconditioned indoor spaces: Ambient temperatures in the range of 20 to 120 degrees F and temperature conditions outside this range normally encountered at the installed location.

- d. Humidity: 10% to 95% relative humidity, noncondensing and humidity conditions outside this range normally encountered at the installed location.

## 2.2 ENCLOSURES AND WEATHERSHIELDS

### 2.2.1 Enclosures

Enclosures shall meet the following minimum requirements:

- a. Outdoors: Enclosures located outdoors shall meet NEMA 250 Type 4 requirements.
- b. Mechanical and Electrical Rooms: Enclosures located in mechanical or electrical rooms shall meet NEMA 250 Type 2 requirements.
- c. Other Locations: Enclosures in other locations including but not limited to occupied spaces, above ceilings, and plenum returns shall meet NEMA 250 Type 1 requirements.

Enclosures supplied as an integral (pre-packaged) part of another product are acceptable.

### 2.2.2 Weathershields

Weathershields for sensors located outdoors shall prevent the sun from directly striking the sensor. The weathershield shall be provided with adequate ventilation so that the sensing element responds to the ambient conditions of the surroundings. The weathershield shall prevent rain from directly striking or dripping onto the sensor. Weathershields installed near outside air intake ducts shall be installed such that normal outside air flow does not cause rainwater to strike the sensor. Weathershields shall be constructed of galvanized steel painted white, unpainted aluminum, aluminum painted white, or white PVC.

## 2.3 TUBING

### 2.3.1 Copper

Copper tubing shall conform to ASTM B 88 and ASTM B 88M

### 2.3.2 Stainless Steel

Stainless steel tubing shall conform to ASTM A 269

### 2.3.3 Plastic

Plastic tubing shall have the burning characteristics of linear low-density polyethylene tubing, shall be self-extinguishing when tested in accordance with ASTM D 635, shall have UL 94 V-2 flammability classification or better, and shall withstand stress cracking when tested in accordance with ASTM D 1693. Plastic-tubing bundles shall be provided with Mylar barrier and flame-retardant polyethylene jacket.

## 2.4 NETWORK HARDWARE

### 2.4.1 ANSI/EIA 709.1B Network Hardware

#### 2.4.1.1 ANSI/EIA 709.1B Routers

ANSI/EIA 709.1B Routers (including routers configured as repeaters) shall meet the requirements of ANSI/EIA 709.1B and shall provide connection between two or more ANSI/EIA 709.3 TP/FT-10 channels.

#### 2.4.1.2 ANSI/EIA 709.3 Repeater

ANSI/EIA 709.3 Repeater shall be physical layer repeaters in accordance with ANSI/EIA 709.3.

#### 2.4.1.3 Gateways

Gateways shall perform bi-directional protocol translation from one non-ANSI/EIA 709.1B protocol to ANSI/EIA 709.1B. Gateways shall incorporate exactly two network connections: one shall be for connection to a TP/FT-10 network in accordance with ANSI/EIA 709.3 and the second shall be as required to communicate with the non-ANSI/EIA 709.1B network.

## 2.5 WIRE AND CABLE

All wire and cable shall meet the requirements of NFPA 70 and NFPA 90A in addition to the requirements of this specification.

### 2.5.1 Terminal Blocks

Terminal blocks which are not integral to other equipment shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, shall be suitable for rail mounting, and shall have end plates and partition plates for separation or shall have enclosed sides.

### 2.5.2 Control Wiring for Binary Signals

Control wiring for binary signals shall be 18 AWG copper and shall be rated for 300-volt service.

### 2.5.3 Wiring for 120-Volt Circuits

Wiring for 120-volt circuits shall be 18 AWG or thicker stranded copper and shall be rated for 600-volt service.

### 2.5.4 Control Wiring for Analog Signals

Control Wiring for Analog Signals shall be 18 AWG, copper, single- or multiple-twisted, minimum 50 mm (2 inch) lay of twist, 100% shielded pairs, and shall have a 300-volt insulation. Each pair shall have a 20 AWG tinned-copper drain wire and individual overall pair insulation. Cables shall have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.

### 2.5.5 Transformers

Transformers shall be UL 1585 approved. Transformers shall be sized so

that the connected load is no greater than 80% of the transformer rated capacity.

## 2.6 AUTOMATIC CONTROL VALVES

Valves shall have stainless-steel stems and stuffing boxes with extended necks to clear the piping insulation. Valve bodies shall meet ANSI/ASME B16.34 or ANSI/ASME B16.15 pressure and temperature class ratings based on the design operating temperature and 150% of the system design operating pressure. Unless otherwise specified or shown, valve leakage shall meet ANSI/FCI 70-2 Class IV leakage rating (0.01% of valve Kv). Unless otherwise specified or shown, valves shall have globe-style bodies. Unless otherwise specified:

- a. bodies for valves 40 mm (1.5 inches) and smaller shall be brass or bronze, with threaded or union ends
- b. bodies for 50 mm (2 inch) valves shall have threaded ends
- c. bodies for valves 50 to 80 mm (2 to 3 inches) shall be of brass, bronze or iron.
- d. bodies for valves 65 mm (2.5 inches) and larger shall be provided with flanged-end connections.
- e. for modulating applications, valve Kv (Cv) shall be within 100 to 125% of the Kv (Cv) shown.
- f. for two position applications (where the two positions are full open and full closed) the Kv (Cv) shall be the largest available for the valve size.
- f. valve and actuator combination shall be normally open or normally closed as shown.

### 2.6.1 Ball Valves

Balls shall be stainless steel or nickel plated brass. Valves shall have blow-out proof stems. In steam and high temperature hot water applications, the valve-to-actuator linkage shall provide a thermal break.

### 2.6.2 Butterfly Valves

Butterfly valves shall be threaded lug type suitable for dead-end service and modulation to the fully-closed position, with carbon-steel bodies and non-corrosive discs, stainless steel shafts supported by bearings, and EPDM seats suitable for temperatures from -29 to +121 degreesC (-20 to +250 degreesF). The rated Kv (Cv) for butterfly valves shall be the value Kv (Cv) at 70% (60 degrees) open position. Valve leakage shall meet ANSI/FCI 70-2 Class VI leakage rating.

### 2.6.3 Two-Way Valves

Two-way modulating valves used for liquids shall have an equal-percentage characteristic. Two-way modulating valves used for steam shall have a linear characteristic.

#### 2.6.4 Three-Way Valves

Three-way modulating valves shall provide equal percentage flow control with constant total flow throughout full plug travel.

#### 2.6.5 Duct-Coil and Terminal-Unit-Coil Valves

Control valves with either flare-type or solder-type ends shall be provided for duct or terminal-unit coils. Flare nuts shall be provided for each flare-type end valve.

#### 2.6.6 Valves for Chilled-Water, Condenser-Water, and Glycol Service

Valve internal trim shall be Type 316 stainless steel. Valves 100 mm (4 inches) and larger shall be butterfly valves.

#### 2.6.7 Valves for High-Temperature Hot-Water, Hot-Water and Dual Temperature Service

Valves for hot water service between 99 degreesC (210 degreesF) and 121 degreesC (250 degreesF) and dual-temperature service shall have internal trim (including seats, seat rings, modulating plugs, and springs) of Type 316 stainless steel. Internal trim for valves controlling water below 99 degreesC (210 degreesF) shall be brass, bronze or Type 316 stainless steel. Nonmetallic valve parts shall be suitable for a minimum continuous operating temperature of 121 degreesC (250 degreesF) or 28 degreesC (50 degreesF) above the system design temperature, whichever is higher. Valves 100 mm (4 inches) and larger shall be butterfly valves.

For high-temperature hot water service above 121 degreesC (250 degreesF) valve bodies shall be carbon steel, globe type with welded ends on valves 25 mm (1 inch) and larger. Valves smaller than 25 mm (1 inch) shall have socket-weld ends. Packing shall be virgin polytetrafluoroethylene (PTFE). Internal valve trim shall be Type 316 stainless steel.

#### 2.6.8 Valves for Steam Service

Bodies for valves 100 mm (4 inches) and larger shall be iron or carbon steel. Internal valve trim shall be Type 316 stainless steel. If the specified Kv (Cv) is not available the valve manufacturer's next largest size shall be used.

### 2.7 DAMPERS

#### 2.7.1 Damper Assembly

A single damper section shall have blades no longer than 1.2m (48 inch) and shall be no higher than 1.8m (72 inch). Maximum damper blade width shall be 203 mm (8in). Larger sizes shall be made from a combination of sections. Dampers shall be steel, or other materials where shown. Flat blades shall be made rigid by folding the edges. Blade-operating linkages shall be within the frame so that blade-connecting devices within the same damper section shall not be located directly in the air stream. Damper axles shall be 13 mm (0.5 inch) minimum, plated steel rods supported in the damper frame by stainless steel or bronze bearings. Blades mounted vertically shall be supported by thrust bearings. Pressure drop through dampers shall not exceed 10Pa (0.04 inches water gauge) at 5.1m/s (1,000ft/min) in the wide-open position. Frames shall not be less than 50 mm (2 inch) in width. Dampers shall be tested in accordance with AMCA 500-D.

### 2.7.2 Operating Linkages

Operating links external to dampers, such as crank arms, connecting rods, and line shafting for transmitting motion from damper actuators to dampers, shall withstand a load equal to at least 300% of the maximum required damper-operating force. Rod lengths shall be adjustable. Links shall be brass, bronze, zinc-coated steel, or stainless steel. Working parts of joints and clevises shall be brass, bronze, or stainless steel. Adjustments of crank arms shall control the open and closed positions of dampers.

### 2.7.3 Damper Types

#### 2.7.3.1 Flow Control Dampers

Outside air, return air, relief air, exhaust, face and bypass dampers shall be provided where shown and shall be parallel-blade or opposed blade type as shown on the Damper Schedule. Blades shall have interlocking edges and shall be provided with compressible seals at points of contact. The channel frames of the dampers shall be provided with jamb seals to minimize air leakage. Unless otherwise shown, dampers shall be AMCA 500-D Class 2 and shall not leak in excess of 102L/s per square meter (20cfm per square foot) at 1017Pa (4 inches water gauge) static pressure when closed. Outside air damper seals shall be suitable for an operating temperature range of -40 to +75 degreesC (-40 to +167 degreesF). Dampers shall be rated at not less than 10m/s (2000ft/min) air velocity.

#### 2.7.3.2 Mechanical Rooms and Other Utility Space Ventilation Dampers

Utility space ventilation dampers shall be as shown. Unless otherwise shown, dampers shall be AMCA 500-D class 4 and shall not leak in excess of 406L/s per square meter (80cfm per square foot) at 1017Pa (4 inches water gauge) static pressure when closed. Dampers shall be rated at not less than 7.6m/s (1500ft/min) air velocity.

#### 2.7.3.3 Smoke Dampers

Smoke-damper and actuator assembly shall meet the current requirements of NFPA 90A, UL 555, and UL 555S. Combination fire and smoke dampers shall be rated for 121 degreesC (250 degreesF) Class II leakage per UL 555S.

## 2.8 SENSORS AND INSTRUMENTATION

Unless otherwise specified, sensors and instrumentation shall incorporate an integral transmitter or be provided with a transmitter co-located with the sensor. Sensors and instrumentation, including their transmitters, shall meet the specified accuracy and drift requirements at the input of the connected DDC Hardware's analog-to-digital conversion. Sensors and instrumentation, including their transmitters, shall meet or exceed the specified range.

### 2.8.1 Transmitters

The transmitter shall match the characteristics of the sensor. Transmitters providing analog values shall produce a linear 4-20 mAdc, 0-10 Vdc or SNVT output corresponding to the required operating range and shall have zero and span adjustment. Transmitters providing binary values shall have dry contacts or SNVT output. Transmitters with SNVT output are Application Specific Controllers (ASCs) and shall meet all ASC

requirements. (note: ASCs are specified in paragraph DIRECT DIGITAL CONTROL (DDC) HARDWARE)

## 2.8.2 Temperature Sensors

### 2.8.2.1 Sensor Ranges and Accuracy

Temperature sensors may be provided without transmitters. Temperature sensors, including transmitter if used, shall have minimum operating ranges, minimum accuracy and maximum drift as specified below for the application:

#### a. Conditioned Space Temperature

- (1) Operating Range: +10 to +30 degreesC (+50 to +86 degreesF)
- (2) Accuracy: +/-0.5 degreesC (1 degreeF) over the operating range.
- (3) Drift: Maximum 0.5 degreesC (1 degreeF) per year

#### b. Unconditioned Space Temperature

- (1) Operating Range: -7 to +66 degreesC (+20 to +150 degreesF)
- (2) Accuracy: +/-0.5 degreesC (1 degreeF) over the range of -1 to +55 degreesC (+30 to +131 degreesF) and +/-2 degreesC (4 degreesF) over the rest of the operating range.
- (3) Drift: Maximum 0.5 degreesC (1 degreeF) per year

#### c. Duct Temperature

- (1) Operating Range: +5 to +60 degreesC (+40 to +140 degreesF)
- (2) Accuracy: +/-1 degreeC (2 degreesF).
- (3) Drift: Maximum 1 degreeC (2 degreesF) per year.

#### d. Outside Air Temperature

- (1) Operating Range: 20 to 120 degrees F.
- (2) Accuracy:
  - (a) +/-1 degreeC (2 degreesF) over the range of -35 to +55 degreesC (-30 to +130 degreesF).
  - (b) +/-0.5 degreesC (1 degreeF) over the range of -1 to +40 degreesC (+30 to +100 degreesF).
- (3) Drift: Maximum 0.5 degreesC (1 degreeF) per year.

#### e. High Temperature Hot Water

- (1) Operating Range: +65 to +232 degreesC (+150 to +450 degreesF).
- (2) Accuracy: +/-2 degreesC (3.6 degreesF).

(3) Drift: Maximum +/-1 degreeC (2 degreesF) per year.

f. Chilled Water

(1) Operating Range: -1 to +38 degreesC (+30 to +100 degreesF)

(2) Accuracy: +/-0.4 degreesC (0.8 degreesF) over the range of +2 to +18 degreesC (+35 to +65 degreesF) and +/-1 degreeC (2 degreesF) over the rest of the operating range

(3) Drift: Maximum 0.4 degreesC (0.8 degreesF) per year

g. Dual Temperature Water

(1) Operating Range: -1 to +116 degreesC (+30 to +240 degreesF)

(2) Accuracy: +/-1 degreeC (2 degreesF).

(3) Drift: Maximum 1 degreeC (2 degreesF) per year

h. Heating Hot Water

(1) Operating Range: +21 to +121 degreesC (+70 to +250 degreesF)

(2) Accuracy: +/-1 degreeC (2 degreesF).

(3) Drift: Maximum 1 degreeC (2 degreesF) per year

i. Condenser Water

(1) Operating Range: -1 to +54 degreesC (+30 to +130 degreesF)

(2) Accuracy: +/-0.6 degreesC (1 degreeF).

(3) Drift: Maximum 0.6 degreesC (1 degreeF) per year

2.8.2.2 Point Temperature Sensors

Point Sensors shall be encapsulated in epoxy, series 300 stainless steel, anodized aluminum, or copper.

2.8.2.3 Averaging Temperature Sensors

Averaging sensors shall be a continuous element with a minimum length equal to 3m per square meter (1 foot per square foot) of duct cross-sectional area at the installed location. The sensing element shall have a bendable copper sheath.

2.8.2.4 Thermowells

Thermowells shall be Series 300 stainless steel with threaded brass plug and chain, 50 mm (2 inch) lagging neck and extension type well. Inside diameter and insertion length shall be as required for the application.

2.8.3 Relative Humidity Sensor

Relative humidity sensors shall use bulk polymer resistive or thin film capacitive type non-saturating sensing elements capable of withstanding a saturated condition without permanently affecting calibration or sustaining

damage. The sensors shall include removable protective membrane filters. Where required for exterior installation, sensors shall be capable of surviving below freezing temperatures and direct contact with moisture without affecting sensor calibration. When used indoors, the sensor shall be capable of being exposed to a condensing air stream (100% RH) with no adverse effect to the sensor's calibration or other harm to the instrument.

The sensor shall be of the wall-mounted or duct-mounted type, as required by the application, and shall be provided with any required accessories. Sensors used in duct high-limit applications shall have a bulk polymer resistive sensing element. Duct-mounted sensors shall be provided with a duct probe designed to protect the sensing element from dust accumulation and mechanical damage.

Relative humidity (RH) sensors shall measure relative humidity over a range of 0% to 100% with an accuracy of  $\pm 3\%$ . RH sensors shall function over a temperature range of -4 to +55 degreesC (25 to 130 degreesF) and shall not drift more than 2% per year.

#### 2.8.4 Carbon Dioxide (CO<sub>2</sub>) Sensors

Carbon dioxide (CO<sub>2</sub>) sensors shall measure CO<sub>2</sub> concentrations between 0 to 2000 parts per million (ppm) using non-dispersive infrared (NDIR) technology with an accuracy of  $\pm 75$  ppm and a maximum response time of 1 minute. The sensor shall be rated for operation at ambient air temperatures within the range of 0 to 50 degreesC (32 to 122 degreesF) and relative humidity within the range of 0 to 95% (non-condensing). The sensor shall have a maximum drift of 2%.

The sensor chamber shall be manufactured with a non-corrosive material (such as gold-plating) that does not affect carbon dioxide sample concentration. Duct mounted sensors shall be provided with a duct probe designed to protect the sensing element from dust accumulation and mechanical damage.

#### 2.8.5 Differential Pressure Instrumentation

##### 2.8.5.1 Differential Pressure Sensors

Differential Pressure Sensor range shall be as shown or as required for the application. Pressure sensor ranges shall not exceed the high end range shown on the Points Schedule by more than 50%. The over pressure rating shall be a minimum of 150% of the highest design pressure of either input to the sensor. The accuracy shall be  $\pm 2\%$  of full scale.

##### 2.8.5.2 Differential Pressure Switch

The switch shall have a user-adjustable setpoint. The setpoint shall not be in the upper or lower quarters of the range. The over pressure rating shall be a minimum of 150% of the highest design pressure of either input to the sensor.

The switch shall have two sets of contacts and each contact shall have a rating greater than it's connected load. Contacts shall open or close upon rise of pressure above the setpoint or drop of pressure below the setpoint as shown.

## 2.8.6 Flow Sensors

### 2.8.6.1 Airflow Measurement Array (AFMA)

AFMAs shall contain an airflow straightener if required by the AFMA manufacturer's published installation instructions. The straightener shall be contained inside a flanged sheet metal casing, with the AFMA located as specified according to the published recommendation of the AFMA manufacturer. In the absence of published documentation airflow straighteners shall be provided if there is any duct obstruction within 5 duct diameters upstream of the AFMA. Air-flow straighteners, where required, shall be constructed of 3 mm (.125 inch) aluminum honeycomb and the depth of the straightener shall not be less than 40 mm (1.5 inches).

The resistance to air flow through the AFMA, including the airflow straightener shall not exceed 20 Pa (0.08 inch water gauge) at an airflow of 10 m/s (2,000 fpm). AFMA construction shall be suitable for operation at airflows of up to 25 m/s (5,000 fpm) over a temperature range of +4 to +49 degreesC (+40 to +120 degreesF).

In outside air measurement or in low-temperature air delivery applications, the AFMA shall be certified by the manufacturer to be accurate as specified over a temperature range of -29 to +49 degreesC (-20 to +120 degreesF).

a. Pitot Tube AFMA: Each Pitot Tube AFMA shall contain an array of velocity sensing elements. The velocity sensing elements shall be of the multiple pitot tube type with averaging manifolds. The sensing elements shall be distributed across the duct cross section in the quantity and pattern specified by the published installation instructions of the AFMA manufacturer.

Pitot Tube AFMAs shall have an accuracy of +/-3% over a range of 2.5 to 12.5m/s (500 to 2,500fpm).

b. Electronic AFMA: Each electronic AFMA shall consist of an array of velocity sensing elements of the resistance temperature detector (RTD) or thermistor type. The sensing elements shall be distributed across the duct cross section in the quantity and pattern specified by the published application data of the AFMA manufacturer.

Electronic AFMAs shall have an accuracy of +/-3% percent over a range of 0.6 to 12.5 m/s (125 to 2,500 fpm) and the output shall be temperature compensated over a range of 0 to 100 degreesC (32 to 212 degreesF).

### 2.8.6.2 Orifice Plate

Orifice plate shall be made of an austenitic stainless steel sheet of 3.3 mm (0.125 inch) nominal thickness with an accuracy of +/-1% of full flow. The orifice plate shall be flat within 0.1 mm (0.002 inches). The orifice surface roughness shall not exceed 0.5 micro-meters (20 micro-inches). The thickness of the cylindrical face of the orifice shall not exceed 2% of the pipe inside diameter or 12.5% of the orifice diameter, whichever is smaller. The upstream edge of the orifice shall be square and sharp. Where orifice plates are used, concentric orifice plates shall be used in all applications except steam flow measurement in horizontal pipelines.

#### 2.8.6.3 Flow Nozzle

Flow nozzle shall be made of austenitic stainless steel with an accuracy of  $\pm 1\%$  of full flow. The inlet nozzle form shall be elliptical and the nozzle throat shall be the quadrant of an ellipse. The thickness of the nozzle wall and flange shall be such that distortion of the nozzle throat from strains caused by the pipeline temperature and pressure, flange bolting, or other methods of installing the nozzle in the pipeline shall not cause the accuracy to degrade beyond the specified limit. The outside diameter of the nozzle flange or the design of the flange facing shall be such that the nozzle throat shall be centered accurately in the pipe.

#### 2.8.6.4 Venturi Tube

Venturi tube shall be made of cast iron or cast steel and shall have an accuracy of  $\pm 1\%$  of full flow. The throat section shall be lined with austenitic stainless steel. Thermal expansion characteristics of the lining shall be the same as that of the throat casting material. The surface of the throat lining shall be machined to a  $\pm 1.2$  micrometer (50 micro inch) finish, including the short curvature leading from the converging entrance section into the throat.

#### 2.8.6.5 Annular Pitot Tube

Annular pitot tube shall be made of austenitic stainless steel with an accuracy of  $\pm 2\%$  of full flow and a repeatability of  $\pm 0.5\%$  of measured value. The unit shall have at least one static port and no less than four total head pressure ports with an averaging manifold.

#### 2.8.6.6 Insertion Turbine Flowmeter

Insertion Turbine Flowmeter accuracy shall be  $\pm 1\%$  of reading for a minimum turndown ratio of 1:1 through a maximum turndown ratio of 50:1. Repeatability shall be  $\pm 0.25\%$  of reading. The meter flow sensing element shall operate over a range suitable for the installed location with a pressure loss limited to 1% of operating pressure at maximum flow rate. Design of the flowmeter probe assembly shall incorporate integral flow, temperature, and pressure sensors. The turbine rotor assembly shall be constructed of Series 300 stainless steel and use Teflon seals.

#### 2.8.6.7 Vortex Shedding Flowmeter

Vortex Shedding Flowmeter accuracy shall be within  $\pm 0.8\%$  of the actual flow. The flow meter body shall be made of austenitic stainless steel. The vortex shedding flowmeter body shall not require removal from the piping in order to replace the shedding sensor.

#### 2.8.6.8 Positive Displacement Flow Meter

The flow meter shall be a direct reading, gerotor, nutating disk or vane type displacement device rated for liquid service as shown. A counter shall be mounted on top of the meter, and shall consist of a non-resettable mechanical totalizer for local reading, and a pulse transmitter for remote reading. The totalizer shall have a six digit register to indicate the volume passed through the meter in gallons, and a sweep-hand dial to indicate down to 0.25 gallons. The pulse transmitter shall have a hermetically sealed reed switch which is activated by magnets fixed on gears of the counter. The meter shall have a bronze body with threaded or flanged connections as required for the application. Output accuracy

shall be +/-2% of the flow range. The maximum pressure drop at full flow shall be 34 kilopascals (5psig).

#### 2.8.6.9 Flow Meters, Paddle Type

Sensor shall be non-magnetic, with forward curved impeller blades designed for water containing debris. Sensor accuracy shall be +/-2% of rate of flow, minimum operating flow velocity shall be 0.3 meters per second (1 foot per second). Sensor repeatability and linearity shall be +/-1%. Materials which will be wetted shall be made from non-corrosive materials and shall not contaminate water. The sensor shall be rated for installation in pipes of 76 mm to 1 m (3 to 40 inch) diameters. The transmitter housing shall be a NEMA 250 Type 4 enclosure.

#### 2.8.6.10 Flow Switch

Flow switch shall have a repetitive accuracy of +/-10% of actual flow setting. Switch actuation shall be adjustable over the operating flow range. The switch shall have Form C snap-action contacts, rated for the application. The flow switch shall have non flexible paddle with magnetically actuated contacts and be rated for service at a pressure greater than the installed conditions. Flow switch for use in sewage system shall be rated for use in corrosive environments encountered.

#### 2.8.6.11 Gas Utility Flow Meter

Gas utility flow meter shall be diaphragm or bellows type (gas positive displacement meters) for flows up to 19.7 liters/sec (2500 SCFH) and axial flow turbine type for flows above 19.7 liters/sec (2500 SCFH), designed specifically for natural gas supply metering, and rated for the pressure, temperature, and flow rates of the installation. Meter shall have a minimum turndown ratio of 10 to 1 with an accuracy of +/-1% of actual flow rate. The meter index shall include a direct reading mechanical totalizing register and electrical impulse dry contact output for remote monitoring. For gas flows of less than 45 cubic-meters/second (1500 cubic-feet/second), the electrical impulse dry contact output shall provide not less than 1 pulse per 3 cubic meters (100 cubic feet) of gas and shall not exceed 15 pulses per second for the installed application. For gas flows 45 cubic-meters/second (1500 cubic-feet/second) or greater, the pulse rate shall not be the greatest pulse-rate available but not to exceed 15 pulses per second for the installed application. The electrical impulse dry contact output shall not require field adjustment or calibration.

#### 2.8.7 Electrical Instruments

Electrical Instruments shall have an input range as shown or sized for the application. Unless otherwise specified, AC instrumentation shall be suitable for 60 Hz operation.

##### 2.8.7.1 Watt or Watthour Transducers

Watt transducers shall measure voltage and current and shall output kW, kWh, or kW and kWh as shown. kW outputs shall have an accuracy of +/-0.25% over a power factor range of .1 to 1. kWh outputs shall be a pulse output and shall have an accuracy of +/-0.5% over a power factor range of .1 to 1.

##### 2.8.7.2 Watthour Revenue Meter (with and without Demand Register)

All Watthour revenue meters shall measure voltage and current and shall be

in accordance with ANSI C12.1 with an ANSI C12.20 Accuracy class of 0.5 and shall have pulse initiators for remote monitoring of Watthour consumption. Pulse initiators shall consist of form C contacts with a current rating not to exceed two amperes and voltage not to exceed 500 V, with combinations of VA not to exceed 100 VA, and a life rating of one billion operations. Meter sockets shall be in accordance with ANSI C12.10.

Watthour revenue meters with demand registers shall have an analog output for instantaneous demand in addition to the pulse initiators.

#### 2.8.7.3 Current Transducers

Current transducers shall accept an AC current input and shall have an accuracy of  $\pm 2\%$  of full scale. An integral power supply shall be provided if required for the analog output signal. The device shall have a means for calibration.

#### 2.8.7.4 Current Sensing Relays (CSRs)

Current sensing relays (CSRs) shall provide a normally-open contact with a voltage and amperage rating greater than its connected load. Current sensing relays shall be of split-core design. The CSR shall be rated for operation at 200% of the connected load. Voltage isolation shall be a minimum of 600 volts. The CSR shall auto-calibrate to the connected load.

#### 2.8.7.5 Voltage Transducers

Voltage transducers shall accept an AC voltage input and have an accuracy of  $\pm 0.25\%$  of full scale. An integral power supply shall be provided if required for the analog output signal. The device shall have a means for calibration. Line side fuses for transducer protection shall be provided.

#### 2.8.8 pH Sensor

The sensor shall be suitable for applications and chemicals encountered in water treatment systems of boilers, chillers and condenser water systems. Construction, wiring, fittings and accessories shall be corrosion and chemical resistant with fittings for tank or suspension installation. Housing shall be polyvinylidene fluoride with O-rings made of chemical resistant materials which do not corrode or deteriorate with extended exposure to chemicals. The sensor shall be encapsulated. Periodic replacement shall not be required for continued sensor operation. Sensors shall use a ceramic junction and pH sensitive glass membrane capable of withstanding a pressure of 689 kilopascals at 66 degreesC (100 psig at 150 degreesF). The reference cell shall be double junction configuration. Sensor range shall be 0 to 12 pH, stability 0.05, sensitivity 0.02, and repeatability of  $\pm 0.05$  pH value, response of 90% of full scale in one second and a linearity of 99% of theoretical electrode output measured at (24 degreesC) (76 degreesF).

#### 2.8.9 Oxygen Analyzer

Oxygen analyzer shall consist of a zirconium oxide sensor for continuous sampling and an air-powered aspirator to draw flue gas samples. The analyzer shall be equipped with filters to remove flue air particles. Sensor probe temperature rating shall be 435 degreesC (815 degreesF). The sensor assembly shall be equipped for flue flange mounting.

#### 2.8.10 Vibration Switch

Vibration switch shall be solid state, enclosed in a NEMA 250 Type 4 or Type 4X housing with sealed wire entry. Unit shall have two independent sets of Form C switch contacts with one set to shutdown equipment upon excessive vibration and a second set for monitoring alarm level vibration. The vibration sensing range shall be a true rms reading, suitable for the application. The unit shall include either displacement response for low speed or velocity response for high speed application. The frequency range shall be at least 2 Hz to 200 Hz. Contact time delay shall be 3 seconds. The unit shall have independent start-up and running delay on each switch contact. Alarm limits shall be adjustable and setpoint accuracy shall be +/-10% of setting with repeatability of plus or minus 2%.

#### 2.8.11 Conductivity Sensor

Sensor shall include local indicating meter and shall be suitable for measurement of conductivity of water in boilers, chilled water systems, condenser water systems, distillation systems, or potable water systems as shown. Sensor shall sense from 0 to 10 microSeimens per centimeter (uS/cm) for distillation systems, 0 to 100 uS/cm for boiler, chilled water, and potable water systems and 0 to 1000 uS/cm for condenser water systems. Contractor shall field verify the ranges for particular applications and adjust the range as required. The output shall be temperature compensated over a range of 0 to 100 degreesC (32 to 212 degreesF). The accuracy shall be +/-2% of the full scale reading. Sensor shall have automatic zeroing and shall require no periodic maintenance or recalibration.

#### 2.8.12 NOx Monitor

Monitor shall continuously monitor and give local indication of boiler stack gas for NOx content. It shall be a complete system designed to verify compliance with the Clean Air Act standards for NOx normalized to a 3% oxygen basis and shall have a range of from 0 to 100 ppm. Sensor shall be accurate to +/-5 ppm. Sensor shall output NOx and oxygen levels and binary output that changes state when the NOx level is above a locally adjustable NOx setpoint. Sensor shall have normal, trouble and alarm lights. Sensor shall have heat traced lines if the stack pickup is remote from the sensor. Sensor shall be complete with automatic zero and span calibration using a timed calibration gas system, and shall not require periodic maintenance or recalibration.

#### 2.8.13 Floor Mounted Leak Detector

Leak detectors shall use electrodes mounted at slab level with a minimum built-in-vertical adjustment of 3 mm (0.125 inches). Detector shall have a binary output. The indicator shall be manual reset type.

## 2.8.14 Temperature Switch

### 2.8.14.1 Duct Mount Temperature Low Limit Safety Switch (Freezestat)

Duct mount temperature low limit switches (Freezestats) shall be manual reset, low temperature safety switches with a minimum element length of 3m per square meter (1 foot per square-foot) of coverage which shall respond to the coldest 450 mm (18 inch) segment with an accuracy of  $\pm 2$  degreesC (3.6 degreesF). The switch shall have a field-adjustable setpoint with a range of at least -1 to +10 degreesC (+30 to +50 degreesF).

The switch shall have two sets of contacts, and each contact shall have a rating greater than its connected load. Contacts shall open or close upon drop of temperature below setpoint as shown and shall remain in this state until reset.

### 2.8.14.2 Pipe Mount Temperature Limit Switch (Aquastat)

Pipe mount temperature limit switches (aquastats) shall have a field adjustable setpoint between 15 and 32 degreesC (60 to 90 degreesF), an accuracy of  $\pm 2$  degreesC (3.6 degreesF) and a 5 degreesC (10 degreesF) fixed deadband.

The switch shall have two sets of contacts, and each contact shall have a rating greater than its connected load. Contacts shall open or close upon change of temperature above or below setpoint as shown.

## 2.8.15 Damper End Switches

Each end switch shall be a hermetically sealed switch with a trip lever and over-travel mechanism. The switch enclosure shall be suitable for mounting on the duct exterior and shall permit setting the position of the trip lever that actuates the switch. The trip lever shall be aligned with the damper blade.

## 2.9 INDICATING DEVICES

All indicating devices shall display readings in English (inch-pound) units.

### 2.9.1 Thermometers

Thermometers shall not contain mercury. Unless otherwise specified, thermometers shall have an accuracy of  $\pm 3\%$  of scale range. Thermometers shall have a range suitable for the application with an upper end of the range not to exceed 150% of the design upper limit.

#### 2.9.1.1 Piping System Thermometers

Piping system thermometers shall have brass, malleable iron or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a 230 mm (9 inch) scale. Piping system thermometers shall have an accuracy of  $\pm 1\%$  of scale range. Thermometers for piping systems shall have rigid stems with straight, angular, or inclined pattern. Thermometer stems shall have expansion heads as required to prevent breakage at extreme temperatures. On rigid-stem thermometers, the space between bulb and stem shall be filled with a heat-transfer medium.

#### 2.9.1.2 Air-Duct Thermometers

Air-duct thermometers shall have perforated stem guards and 45-degree adjustable duct flanges with locking mechanism.

#### 2.9.2 Pressure Gauges

Gauges shall be suitable for field or panel mounting as required, shall have black legend on white background, and shall have a pointer traveling through a 270-degree arc. Gauge range shall be suitable for the application with an upper end of the range not to exceed 150% of the design upper limit. Accuracy shall be  $\pm 3\%$  of scale range. Gauges shall meet requirements of ASME B40.1.

#### 2.9.3 Low Differential Pressure Gauges

Gauges for low differential pressure measurements shall be a minimum of 90 mm (3.5 inch) (nominal) size with two sets of pressure taps, and shall have a diaphragm-actuated pointer, white dial with black figures, and pointer zero adjustment. Gauge range shall be suitable for the application with an upper end of the range not to exceed 150% of the design upper limit. Accuracy shall be plus or minus two percent of scale range.

### 2.10 OUTPUT DEVICES

Output Devices with SNVT input are ASCs and shall meet all ASC requirements in addition to the output device requirements. (note: ASCs are specified in paragraph DIRECT DIGITAL CONTROL (DDC) HARDWARE.)

#### 2.10.1 Actuators

Actuators shall be electric (electronic) . All actuators shall be normally open (NO), normally closed (NC) or fail-in-last-position (FILP) as shown. Normally open and normally closed actuators shall be of mechanical spring return type. Electric actuators shall have an electronic cut off or other means to provide burnout protection if stalled. Actuators shall have a visible position indicator. Actuators shall smoothly open or close the devices to which they are applied. Pneumatic actuators shall have a full stroke response time matching the connected Electric to Pneumatic Transducer (EP). Electric actuators shall have a full stroke response time in both directions of 90 seconds or less at rated load. Electric actuators shall be of the foot-mounted type with an oil-immersed gear train or the direct-coupled type. Where multiple electric actuators operate from a common signal, the actuators shall provide an output signal identical to its input signal to the additional devices.

##### 2.10.1.1 Valve Actuators

Valve actuators shall provide shutoff pressures and torques as shown on the Valve Schedule.

##### 2.10.1.2 Damper Actuators

Damper actuators shall provide the torque necessary per damper manufacturer's instructions to modulate the dampers smoothly over its full range of operation and torque shall be at least .7 Nm (6 inch-pounds) per .93 square meters (1 square foot) of damper area for opposed blade dampers and 1 Nm (9 inch-pounds) per .93 square meters (1 square foot) of damper area

for parallel blade dampers.

#### 2.10.1.3 Positive Positioners

Positive positioners shall be a pneumatic relay with a mechanical position feedback mechanism and an adjustable operating range and starting point.

#### 2.10.2 Solenoid-Operated Electric to Pneumatic Switch (EPS)

Solenoid-Operated Electric to Pneumatic Switches (EPS) shall accept a voltage input to actuate its air valve. Each valve shall have three-port operation: common, normally open, and normally closed. Each valve shall have an outer cast aluminum body and internal parts of brass, bronze, or stainless steel. The air connection shall be a 10 mm (0.38 inch) NPT threaded connection. Valves shall be rated for 345 kPa (50 psig).

#### 2.10.3 Electric to Pneumatic Transducers (EP)

Electric to Pneumatic Transducers (EPs) shall convert either a 4-20 mAdc input signal, a 0-10 Vdc input signal, or SNVT input to a 21-103 kPa (3-15 psig) pneumatic output with a conversion accuracy of +/-2% of full scale, including linearity and hysteresis. The EP shall withstand pressures at least 150% of the system supply air pressure (main air). EPs shall include independent offset and span adjustment. Air consumption shall not be greater than 0.024 L/s (0.05 scfm). EPs shall have a manual adjustable override for the EP pneumatic output. EPs shall have sufficient output capacity to provide full range stroke of the actuated device in both directions within 90 seconds.

#### 2.10.4 Relays

Control relay contacts shall have utilization category and ratings selected for the application, with a minimum of two sets of contacts enclosed in a dust proof enclosure. Each set of contacts shall incorporate a normally open (NO), normally closed (NC) and common contact. Relays shall be rated for a minimum life of one million operations. Operating time shall be 20 milliseconds or less. Relays shall be equipped with coil transient suppression devices to limit transients to 150% of rated coil voltage.

### 2.11 USER INPUT DEVICES

User Input Devices, including potentiometers, switches and momentary contact push-buttons with SNVT output are Application Specific Controllers (ASCs) and shall meet all ASC requirements. (note: ASCs are specified in paragraph DIRECT DIGITAL CONTROL (DDC) HARDWARE) Potentiometers shall be of the thumb wheel or sliding bar type. Momentary Contact Push-Buttons may include an adjustable timer for their output. User input devices shall be labeled for their function.

### 2.12 MULTIFUNCTION DEVICES

Multifunction devices are products which combine the functions of multiple sensor, user input or output devices into a single product. Unless otherwise specified, the multifunction device shall meet all requirements of each component device. Where the requirements for the component devices conflict, the multifunction device shall meet the most stringent of the requirements.

### 2.12.1 Current Sensing Relay Command Switch

The Current Sensing Relay portion shall meet all requirements of the Current Sensing Relay input device. The Command Switch portion shall meet all requirements of the Relay output device except that it shall have at least one normally-open (NO) contact.

### 2.12.2 Thermostats

Thermostats shall be multifunction devices incorporating a temperature sensor and a temperature indicating device. Thermostats shall not contain mercury (Hg).

In addition, the thermostat shall have the following as specified and shown:

- a. A User Input Device which shall adjust a temperature setpoint output.
- b. A User Input Momentary Contact Button and an output indicating zone occupancy.
- c. A three position User Input Switch labeled to indicate heating, cooling and off positions ('HEAT-COOL-OFF' switch) and providing corresponding outputs.
- d. A two position User Input Switch labeled with 'AUTO' and 'ON' positions and providing corresponding outputs.
- e. A multi-position User Input Switch with 'OFF' and at least two fan speed positions and providing corresponding outputs.

## 2.13 DIRECT DIGITAL CONTROL (DDC) HARDWARE

### 2.13.1 General Requirements

All DDC Hardware shall meet the following requirements:

- a. It shall incorporate a "service pin" which, when pressed will cause the DDC Hardware to broadcast its 48-bit NodeID and its ProgramID over the network. The service pin shall be distinguishable and accessible.
- b. It shall incorporate a light to indicate the device is receiving power.
- c. It shall incorporate a TP/FT-10 transceiver in accordance with ANSI/EIA 709.3 and connections for TP/FT-10 control network wiring. It shall not have connections to any other network media type.
- d. It shall communicate on the network using only the ANSI/EIA 709.1B protocol.
- e. It shall be locally powered; link powered devices are not acceptable.
- f. LonMark external interface files (XIF files), as defined in the LonMark XIF Guide, shall be submitted for each type of DDC Hardware.

g. Application programs and configuration settings shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration settings.

h. It shall have all functionality specified and required to support the application (Sequence of Operation or portion thereof) in which it is used, including but not limited to:

(1) It shall provide input and output SNVTs as specified and required to support the sequence and application in which it is used.

(2) It shall be configurable via standard or user-defined configuration parameters (SCPT or UCPT), SNVT network configuration inputs (*nci*), or hardware settings on the controller itself as specified and as required to support the sequence and application in which it is used.

i. It shall meet FCC Part 15 requirements and have UL 916 or equivalent safety listing.

#### 2.13.2 Hardware Input-Output (I/O) Functions

DDC Hardware incorporating hardware input-output (I/O) functions shall meet the following requirements:

a. Analog Inputs: DDC Hardware analog inputs (AIs) shall perform analog to digital (A-to-D) conversion with a minimum resolution of 8 bits plus sign or better as needed to meet the accuracy requirements specified in paragraph INPUT MEASUREMENT ACCURACY. Signal conditioning including transient rejection shall be provided for each analog input. Analog inputs shall be capable of being individually calibrated for zero and span. The AI shall incorporate common mode noise rejection of at least 50 dB from 0 to 100 Hz for differential inputs, and normal mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10,000 ohms.

b. Analog Outputs: DDC Hardware analog outputs (AOs) shall perform digital to analog (D-to-A) conversion with a minimum resolution of 8 bits plus sign, and output a signal with a range of 4-20 mAdc or 0-10 Vdc. Analog outputs shall be capable of being individually calibrated for zero and span.

c. Binary Inputs: DDC Hardware binary inputs (BIs) shall accept contact closures and shall ignore transients of less than 5 milli-second duration. Isolation and protection against an applied steady-state voltage up to 180 Vac peak shall be provided.

d. Binary Outputs: DDC Hardware binary outputs (BOs) shall provide relay contact closures or triac outputs for momentary and maintained operation of output devices.

(1) Relay Contact Closures: Closures shall have a minimum duration of 0.1 second. Relays shall provide at least 180V of isolation. Electromagnetic interference suppression shall be provided on all output lines to limit transients to non-damaging levels. Minimum contact rating shall be one ampere at 24 Vac.

(2) Triac outputs: Triac outputs shall provide at least 180 V of

isolation.

e. Pulse Accumulator: DDC Hardware pulse accumulators shall have the same characteristics as the BI. In addition, a buffer shall be provided to totalize pulses. The pulse accumulator shall accept rates of at least 20 pulses per second. The totalized value shall be reset to zero upon operator's command.

#### 2.13.3 Application Specific Controller (ASC)

Application Specific Controllers (ASCs) have a fixed factory-installed application program (i.e. ProgramID) with configurable settings. ASCs shall meet the following requirements in addition to the General DDC Hardware and DDC Hardware Input-Output (I/O) Function requirements:

a. ASCs shall be LonMark Certified.

b. Unless otherwise approved, all necessary Configuration Parameters and network configuration inputs (ncis) for the sequence and application in which the ASC is used shall be fully configurable through an LNS plug-in. This plug-in shall be submitted as specified for each type of ASC (manufacturer and model). (note: configuration accomplished via hardware settings does not require configuration via plug-in)

##### 2.13.3.1 Local Display Panel (LDP)

The Local Display Panel shall be an Application Specific Controller (ASC) with a display and navigation buttons. It shall provide display and adjustment of SNVT inputs and SNVT outputs as shown.

#### 2.13.4 General Purpose Programmable Controller (GPPC)

A General Purpose Programmable Controller (GPPC) is not installed with a fixed factory-installed application program. GPPCs shall meet the following requirements in addition to the general DDC Hardware requirements and Hardware Input-Output (I/O) Function:

a. The programmed GPPC shall conform to the LonMark Interoperability Guide.

b. All programming software required to program the GPPC shall be delivered to and licensed to the project site as specified.

c. Copies of the installed GPPC application programs as source code compatible with the supplied programming software shall be submitted as specified. The submitted GPPC application program shall be the complete application necessary for the GPPC to function as installed and be sufficient to allow replacement of the installed controller with a GPPC of the same type.

### PART 3 EXECUTION

#### 3.1 EXISTING CONDITIONS SURVEY

The Contractor shall perform a field survey, including testing and inspection of the equipment to be controlled and submit an Existing Conditions Report documenting the current status and it's impact on the Contractor's ability to meet this specification. For those items

considered nonfunctional, the Contractor shall provide (with the report) specification sheets, or written functional requirements to support the findings and the estimated costs to correct the deficiencies. As part of the report, the Contractor shall define the scheduled need date for connection to existing equipment.

### 3.2 CONTROL SYSTEM INSTALLATION

#### 3.2.1 General Installation Requirements

##### 3.2.1.1 HVAC Control System

The HVAC control system shall be completely installed, tested and ready for operation. Dielectric isolation shall be provided where dissimilar metals are used for connection and support. Penetrations through and mounting holes in the building exterior shall be made watertight. The HVAC control system installation shall provide clearance for control system maintenance by maintaining access space required to calibrate, remove, repair, or replace control system devices. The control system installation shall not interfere with the clearance requirements for mechanical and electrical system maintenance.

##### 3.2.1.2 Device Mounting Criteria

All devices shall be installed in accordance with manufacturer's recommendations and as specified and shown. Control devices to be installed in piping and ductwork shall be provided with required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Strap-on temperature sensing elements shall not be used except as specified. Spare thermowells shall be installed adjacent to each thermowell containing a sensor and as shown. Devices located outdoors shall have a weathershield.

##### 3.2.1.3 Labels and Tags

Labels and tags shall be keyed to the unique identifiers shown on the As-Built drawings. All Enclosures and DDC Hardware shall be labeled. All sensors and actuators in mechanical rooms shall be tagged. Airflow measurement arrays shall be tagged to show flow rate range for signal output range, duct size, and pitot tube AFMA flow coefficient. Duct static pressure taps shall be tagged at the location of the pressure tap. Tags shall be plastic or metal and shall be mechanically attached directly to each device or attached by a metal chain or wire. Labels exterior to protective enclosures shall be engraved plastic and mechanically attached to the enclosure or DDC Hardware. Labels inside protective enclosures may be attached using adhesive, but shall not be hand written.

##### 3.2.2 DDC Hardware

DDC Hardware shall be installed in an enclosure. Except for DDC Hardware used to control Terminal Units, where multiple pieces of DDC Hardware are used to execute one sequence all DDC Hardware executing that sequence shall be on a common local control bus and isolated from all other DDC Hardware via an ANSI/EIA 709.1B Router or ANSI/EIA 709.3 Repeater.

All DDC Hardware installed shall have an ANSI/EIA 709.1B domain of [\_\_\_\_] and a subnet between [\_\_\_\_] and [\_\_\_\_].

### 3.2.3 Local Display Panel (LDP)

Local Display Panels shall be installed [in each mechanical room containing an air handler] [\_\_\_\_] and shall provide SNVT inputs for display and outputs for adjusting SNVT values as shown on the Points Schedule.

### 3.2.4 Gateways

Gateways may be used for communication with non-ANSI/EIA 709.1B control hardware subject to all of the following limitations:

- a. Each gateway shall communicate with and perform protocol translation for non-ANSI/EIA 709.1B control hardware controlling one and only one package unit.
- b. Non-ANSI/EIA 709.1B control hardware shall not be used for controlling built-up units.
- c. Non-ANSI/EIA 709.1B control hardware shall not perform system scheduling functions.

### 3.2.5 Network Interface Jack

A standard network interface jack shall be provided for each node on the control network. For terminal unit controllers with hardwired thermostats this network interface jack shall be located at the thermostat or within 3 m (10 ft) of the controller. Locating the interface jack at the thermostat is preferred. For all other nodes the network interface jack shall be located within 3 m (10 ft) of the node. If the network interface jack is other than an 1/8 inch phone jack, the Contractor shall provide an interface cable with a standard 1/8 inch phone jack on one end and a connector suitable for mating with installed network interface jack on the other. No more than one type of interface cable shall be required to access all network interface jacks. Contractor shall furnish one interface cable(s).

### 3.2.6 Room Instrument Mounting

Room instruments, including but not limited to wall mounted thermostats and sensors located in occupied spaces shall be mounted 1.5m (60 inches) above the floor unless otherwise shown.

Unless otherwise shown on the Thermostat Schedule:

- a. Thermostats for Fan Coil Units shall be unit mounted.
- b. All other Thermostats shall be wall mounted.

### 3.2.7 Indication Devices Installed in Piping and Liquid Systems

Gauges in piping systems subject to pulsation shall have snubbers. Gauges for steam service shall have pigtail fittings with cock. Thermometers and temperature sensing elements installed in liquid systems shall be installed in thermowells.

### 3.2.8 Duct Smoke Detectors

Duct smoke detectors will be provided in supply and return air ducts in accordance with Section 13851A FIRE DETECTION AND ALARM SYSTEM, ADDRESSABLE.

Contractor shall connect the DDC System to the auxiliary contacts provided on the Smoke Detector as required for system safeties and to provide alarms to the DDC system.

### 3.2.9 Occupancy Sensors

A sufficient quantity of occupancy sensors shall be provided to provide complete coverage of the area (room or space). Occupancy sensors shall be installed in accordance with NFPA 70 requirements and the manufacturer's instructions. Occupancy sensors shall not be located within 1.8 m (6 feet) of HVAC outlets or heating ducts. PIR and dual-technology PIR/ultrasonic sensors shall not be installed where they can "see" beyond any doorway. Ultrasonic sensors shall not be installed in spaces containing ceiling fans. Sensors shall detect motion to within 0.6 m (2 feet) of all room entrances and shall not trigger due to motion outside the room. The off-delay timer shall be set to 15 minutes unless otherwise shown. All sensor adjustments shall be made prior to beneficial occupancy, but after installation of furniture systems, shelving, partitions, etc. Each controlled area shall have one hundred percent coverage capable of detecting small hand-motion movements, accommodating all occupancy habits of single or multiple occupants at any location within the controlled room.

### 3.2.10 Temperature Limit Switch

A temperature limit switch (freezestat) shall be provided to sense the temperature at the location shown. A sufficient number of temperature limit switches (freezestats) shall be installed to provide complete coverage of the duct section. Manual reset limit switches shall be installed in approved, accessible locations where they can be reset easily. The temperature limit switch (freezestat) sensing element shall be installed in a serpentine pattern and in accordance with the manufacturer's installation instructions.

### 3.2.11 Averaging Temperature Sensing Elements

Sensing elements shall be installed in a serpentine pattern located as shown.

### 3.2.12 Air Flow Measurement Arrays (AFMA)

Outside Air AFMAs shall be located downstream from the Outside Air filters. Pitot Tube AFMA shall not be used if the expected velocity measurement is below 3.5 m/s (700 fpm) [ or for outside airflow measurements].

### 3.2.13 Duct Static Pressure Sensors

The duct static pressure sensing tap shall be located at 75% to 100% of the distance between the first and last air terminal units. If the transmitter is wired in a homerun configuration to an AHU controller, the transmitter shall be located in the same enclosure as the air handling unit (AHU) controller(s) for the AHU serving the terminal units.

### 3.2.14 Relative Humidity Sensors

Relative humidity sensors in supply air ducts shall be installed at least 3m (10 feet) downstream of humidity injection elements.

### 3.2.15 Flowmeters

The minimum straight unobstructed piping for the flowmeter installation shall be at least 10 pipe diameters upstream and at least 5 pipe diameters downstream and in accordance with the manufacturer's installation instructions.

### 3.2.16 Dampers

#### 3.2.16.1 Damper Actuators

Actuators shall not be mounted in the air stream. Multiple actuators shall not be connected to a common drive shaft. Actuators shall be installed so that their action shall seal the damper to the extent required to maintain leakage at or below the specified rate and shall move the blades smoothly.

#### 3.2.16.2 Damper Installation

Dampers shall be installed straight and true, level in all planes, and square in all dimensions. Dampers shall move freely without undue stress due to twisting, racking (parallelogramming), bowing, or other installation error. Blades shall close completely and leakage shall not exceed that specified at the rated static pressure. Structural support shall be used for multi-section dampers. Acceptable methods include but are not limited to U-channel, angle iron, corner angles and bolts, bent galvanized steel stiffeners, sleeve attachments, braces, and building structure. Where multi-section dampers are installed in ducts or sleeves, they shall not sag due to lack of support. Jackshafts shall not be used to link more than three damper sections. Blade to blade linkages shall not be used.

Outside and return air dampers shall be installed such that their blades direct their respective air streams towards each other to provide for maximum mixing of air streams.

### 3.2.17 Valves

#### 3.2.17.1 Ball Valves

Two-position (open/closed) ball valves may only be used on chilled water, condenser water, hot water, or steam applications. Modulating ball valves may only be used for chilled water and condenser water applications (modulating ball valves shall not be used on steam or hot water applications). In modulating applications a characterizing equal-percentage disc shall be used.

#### 3.2.17.2 Butterfly Valves

In two-way control applications, valve travel shall be limited to 70% (60 degrees) open position.

### 3.2.18 Local Gauges for Actuators

Pneumatic actuators shall have an accessible and visible pressure gauge installed in the tubing lines at the actuator as shown.

### 3.2.19 Wire and Cable

Wire and Cable shall be installed without splices between control devices and in accordance with NFPA 70 and NFPA 90A. Instrumentation grounding

shall be installed per the device manufacturer's instructions and as necessary to prevent ground loops, noise, and surges from adversely affecting operation of the system. Ground rods installed by the Contractor shall be tested as specified in IEEE Std 142. Cables and conductor wires shall be tagged at both ends, with the identifier shown on the shop drawings. Electrical work shall be as specified in Section 16415A ELECTRICAL WORK, INTERIOR and as shown.

Wiring external to enclosures shall be run in raceways as follows:

- a. Wiring other than low-voltage control and low-voltage network wiring shall be installed in raceways.
- b. Low-voltage control and low-voltage network wiring not in suspended ceilings over occupied spaces shall be installed in raceways, except that nonmetallic-sheathed cables or metallic-armored cables may be installed as permitted by NFPA 70.
- c. Low-voltage control and low-voltage network wiring in suspended ceilings over occupied spaces shall be installed in raceways, except:
  - (1) nonmetallic-sheathed cables or metallic-armored cables may be installed as permitted by NFPA 70.
  - (2) plenum rated cable in suspended ceilings over occupied spaces may be run without raceways.

### 3.2.20 Copper Tubing

Copper tubing shall be hard-drawn in exposed areas and either hard-drawn or annealed in concealed areas. Only tool-made bends shall be used. Fittings for copper tubing shall be brass or copper solder joint type except at connections to apparatus, where fittings shall be brass compression type.

### 3.2.21 Plastic Tubing

Plastic tubing shall be run within covered raceways or conduit except when otherwise specified. Plastic tubing shall not be used for applications where the tubing could be subjected to a temperature exceeding 55 degrees C (130 degrees F). Fittings for plastic tubing shall be for instrument service and shall be brass or acetal resin of the compression or barbed push-on type.

Except in walls and exposed locations, plastic multitube instrument tubing bundle without conduit or raceway protection may be used where a number of air lines run to the same points, provided the multitube bundle is enclosed in a protective sheath, is run parallel to the building lines and is adequately supported as specified.

### 3.2.22 Pneumatic Lines

Pneumatic lines shall be installed such that they are not exposed to outside air temperatures. Pneumatic lines shall be concealed except in mechanical rooms and other areas where other tubing and piping is exposed. All tubes and tube bundles exposed to view shall be installed neatly in lines parallel to the lines of the building. Tubing in mechanical/electrical spaces shall be routed so that the lines are easily traceable.

Air lines shall be purged of dirt, impurities and moisture before connecting to the control equipment. Air lines shall be number coded or color coded and keyed in the As-Built Drawings for future identification and servicing the control system.

#### 3.2.22.1 Pneumatic Lines in Mechanical/Electrical Spaces

In mechanical/electrical spaces, pneumatic lines shall be plastic or copper tubing. Horizontal and vertical runs of plastic tubing or soft copper tubing shall be installed in raceways or rigid conduit dedicated to tubing. Dedicated raceways, conduit, and hard copper tubing not installed in raceways shall be supported every 2m (6feet) for horizontal runs and every 2.5m (8feet) for vertical runs.

#### 3.2.22.2 Pneumatic Lines External to Mechanical/Electrical Spaces

Tubing external to mechanical/electrical spaces shall be soft copper with sweat fittings or plastic tubing in raceways not containing power wiring. Raceways and tubing not in raceways shall be supported every 2.5m (8 feet).

Pneumatic lines concealed in walls shall be hard-drawn copper tubing or plastic tubing in rigid conduit. Plastic tubing in a protective sheath, run parallel to the building lines and supported as specified, may be used above accessible ceilings and in other concealed but accessible locations.

#### 3.2.22.3 Terminal Single Lines

Terminal single lines shall be hard-drawn copper tubing, except when the run is less than 300 mm (12in) in length, flexible polyethylene may be used.

#### 3.2.22.4 Connection to Liquid and Steam Lines

Tubing for connection of sensing elements and transmitters to liquid and steam lines shall be copper with brass compression fittings.

#### 3.2.22.5 Connection to Ductwork

Connections to sensing elements in ductwork shall be plastic tubing.

#### 3.2.22.6 Tubing in Concrete

Tubing in concrete shall be installed in rigid conduit. Tubing in walls containing insulation, fill, or other packing materials shall be installed in raceways dedicated to tubing.

#### 3.2.22.7 Tubing Connection to Actuators

Final connections to actuators shall be plastic tubing 300 mm (12 inches) long and unsupported at the actuator.

### 3.3 DRAWINGS AND CALCULATIONS

Contractor shall prepare and submit shop drawings.

#### 3.3.1 Network Bandwidth Usage Calculations

The Contractor shall perform Building Control Network Bandwidth Usage Calculations for a normally loaded and a heavily loaded control network.

Calculations shall be performed for network traffic on the backbone.

A heavily loaded control network is characterized as one performing the following activities simultaneously:

- a. Transmitting every point in the building indicated on Points Schedules as being available to [the UMCS] [the Building Point of Connection (BPOC) location] [a single point on the backbone that is not on a local control bus] in response to polling requests at 15-minute intervals (for trending at UMCS).
- b. Transmitting five points to [the UMCS] [the Building Point of Connection (BPOC) location] [a single point on the backbone that is not on a local control bus] in response to polling requests at 2-second intervals.
- c. Transmitting 100 points to [the UMCS] [the Building Point of Connection (BPOC) location] [a single point on the backbone that is not on a local control bus] in response to polling requests at 5-second intervals.
- d. Transmitting occupancy commands from [the UMCS] [the Building Point of Connection (BPOC) location] [a single point on the backbone that is not on a local control bus] to every system schedule sequence in a one-minute interval.
- e. Transmitting occupancy override commands from [the UMCS] [the Building Point of Connection (BPOC) location] [a single point on the backbone that is not on a local control bus] to every system schedule sequence in a one-minute interval.

A normally loaded control network is characterized as one performing the following activities simultaneously:

- a. Transmitting every point in the building indicated on Points Schedules as requiring a trend to the UMCS in response to polling requests at 15-minute intervals (for trending at UMCS).
- b. Transmitting 50 points to the UMCS in response to polling requests at 5-second intervals.
- c. Transmitting occupancy commands from the UMCS to every system scheduler sequence in a one-minute interval.

### 3.3.2 DDC Contractor Design Drawings

Drawings shall be on ISO A1 (841 by 594 mm) or 34 by 22 inches or A3 (420 by 297 mm) or 17 by 11 inches sheets in the form and arrangement shown. The drawings shall use the same abbreviations, symbols, nomenclature and identifiers shown. Each control system element on a drawing shall be assigned a unique identifier as shown. The DDC Contractor Design Drawings shall be delivered together as a complete submittal. Deviations shall be approved by the Contracting Officer. DDC Contractor Design Drawings shall include the following:

- a. Drawing Index and HVAC Design Drawing Legend: The HVAC Control System Drawing Index shall show the name and number of the building, military site, State or other similar designation, and Country. The Drawing Index shall list all Contractor Design Drawings, including the

drawing number, sheet number, drawing title, and computer filename when used. The Design Drawing Legend shall show and describe all symbols, abbreviations and acronyms used on the Design Drawings.

b. Valve Schedule: The valve schedule shall contain each valve's unique identifier, size, flow coefficient Kv (Cv), pressure drop at specified flow rate, spring range, positive positioner range, actuator size, close-off pressure to torque data, dimensions, and access and clearance requirements data. The valve schedule shall contain actuator selection data supported by calculations of the force required to move and seal the valve, access and clearance requirements. A valve schedule shall be submitted for each HVAC system.

c. Damper Schedule: The damper schedule shall contain each damper's unique identifier, type (opposed or parallel blade), nominal and actual sizes, orientation of axis and frame, direction of blade rotation, actuator size and spring ranges, operation rate, positive positioner range, location of actuators and damper end switches, arrangement of sections in multi-section dampers, and methods of connecting dampers, actuators, and linkages. The Damper Schedule shall include the AMCA 500-D maximum leakage rate at the operating static-pressure differential. A damper schedule shall be submitted for each HVAC system.

d. Thermostat and Occupancy Sensor Schedule: The thermostat and occupancy sensor schedule shall contain each thermostat's unique identifier, room identifier and control features and functions as shown. A thermostat and occupancy sensor schedule shall be submitted for each HVAC system.

e. Critical Alarm Handling Schedule: The critical alarm handling schedule shall contain the same fields as the critical alarm handling schedule Contract Drawing with Contractor updated information and any other project-specific information required to implement the alarm handling function. A critical alarm handling schedule shall be submitted for each HVAC system.

f. Equipment Schedule: The equipment schedule shall contain the unique identifier, manufacturer, model number, part number and descriptive name for each control device, hardware and component provided under this specification. An equipment schedule shall be submitted for each HVAC system.

g. Occupancy Schedule: The occupancy schedule drawing shall contain the same fields as the occupancy schedule Contract Drawing with Contractor updated information. An occupancy schedule shall be submitted for each HVAC system.

h. Points Schedule: The Points Schedule drawing shall contain the same fields as the Points Schedule Contract Drawing with Contractor updated information. A Points Schedule shall be submitted for each HVAC system.

i. Compressed Air Station Schematic: The compressed air station schematic diagram shall show all equipment, including: compressor with motor horsepower and voltage; starter; isolators; manual bypasses; tubing sizes; drain piping and drain traps; reducing valves; dryer; and data on manufacturer's names and model numbers, mounting, access, and clearance requirements. Air Compressor and air dryer data shall include calculations of the air consumption of all

electric-to-pneumatic transducers and of any other control system devices to be connected to the compressed air station, and the compressed air supply dewpoint temperature at 140kPa (20psig). Compressed air station schematic drawings shall be submitted for each compressed air station.

j. Riser diagram of building control network: The Riser Diagram of the Building Control Network shall show all network cabling, DDC Hardware, and Network Hardware including:

- (1) All DDC Hardware with room number and location within room.
- (2) DDC Hardware unique identifiers and common descriptive names.
- (3) All Network hardware with room number and location within room.
- (4) Network hardware unique identifiers.
- (5) All cabling.
- (6) Room number and location within room of all cabling termination points.
- (7) Room number and location within room of all network interface jacks.

A single riser diagram shall be submitted for each building.

k. Control System Schematics: The control system schematics shall be in the same form as the control system schematic Contract Drawing with Contractor updated information. A control system schematic shall be submitted for each HVAC system.

l. Sequences of Operation including Control Logic Diagrams: The HVAC control system sequence of operation and control logic diagrams shall be in the same format as the Contract Drawings and shall refer to the devices by their unique identifiers. No operational deviations from specified sequences will be permitted without prior written approval of the Government. Sequences of operation and control logic diagrams shall be submitted for each HVAC control system.

m. Controller, Motor Starter and Relay Wiring Diagram: The controller wiring diagrams shall be functional wiring diagrams which show the interconnection of conductors and cables to each controller and to the identified terminals of input and output devices, starters and package equipment. The wiring diagrams shall show necessary jumpers and ground connections. The wiring diagrams shall show the labels of all conductors. Sources of power required for control systems and for packaged equipment control systems shall be identified back to the panel board circuit breaker number, controller enclosures, magnetic starter, or packaged equipment control circuit. Each power supply and transformer not integral to a controller, starter, or packaged equipment shall be shown. The connected volt-ampere load and the power supply volt-ampere rating shall be shown. Wiring diagrams shall be submitted for each HVAC control system.

### 3.3.3 Draft As-Built Drawings

The Contractor shall update the Contractor Design Drawings with all as-built data and submit as specified.

### 3.3.4 Final As-Built Drawings

The Contractor shall update the Draft As-Built Drawings with all final as-built data and submit as specified.

## 3.4 HVAC SYSTEMS SEQUENCES OF OPERATION

### 3.4.1 Alarm Handling

The Contractor shall install and configure DDC Hardware to provide alarm handling functionality for critical alarms as specified and shown, either in a piece of DDC Hardware dedicated to this function or in DDC Hardware performing other functions. The DDC Hardware providing alarm handling functionality shall provide the following capabilities as required:

a. Dial to a pager: The node shall be able to dial a paging service and leave a numeric message.

[b. Dial to an e-mail server: The node shall be able to dial and connect to a remote server and send an e-mail via Simple Mail Transfer Protocol (SMTP).]

[c. Send e-mail over IP Network: The alarm handling node shall be capable of connecting to an IP network and sending e-mail via Simple Mail Transfer Protocol (SMTP).]

[d. Provide network access: The node shall be capable of receiving a connection via the modem to allow a remote computer access to the control network.]

### 3.4.2 Scheduling

#### 3.4.2.1 System Mode

AHUs shall operate in Occupied, Warm-Up-Cool-Down, or Unoccupied modes as specified. VAV boxes, Fan Coils, and other terminal equipment shall operate in Occupied or Unoccupied modes as specified. Chillers, boilers, and other sources of heating/cooling for hydronic loads do not require scheduling; these systems receive requests for heating/cooling from their loads.

#### 3.4.2.2 System Scheduler Requirements

The System Scheduler functionality shall reside in either a piece of DDC Hardware dedicated to this functionality or in the DDC Hardware controlling the system AHU. A single piece of DDC Hardware may contain multiple System Schedulers. A unique System Scheduler shall be provided for: each AHU including it's associated Terminal Units, and each stand-alone Terminal Unit (those not dependent upon AHU service) [ or group of stand-alone Terminal Units acting according to a common schedule]. Each System Scheduler shall provide the following functionality:

a. Scheduled Occupancy Input: Accept network variable of type SNVT\_occupancy (as defined in the LonMark SNVT Master List). Input shall support the following possible values: OC\_STANDBY, OC\_OCCUPIED

and OC\_UNOCCUPIED.

b. Occupancy Override Input: Accept network variable of type SNVT\_occupancy (as defined in the LonMark SNVT Master List). Input shall support the following possible values: OC\_STANDBY, OC\_OCCUPIED, OC\_UNOCCUPIED, and OC\_NUL.

c. Space Occupancy Inputs: For systems with multiple occupancy sensors, accept multiple inputs of network variable type SNVT\_Occupancy (as defined in the LonMark SNVT Master List). Input shall support the following possible values: OC\_OCCUPIED, OC\_UNOCCUPIED, and OC\_NUL.

For systems with a single occupancy sensor, accept a network variable input of type SNVT\_Occupancy or a hardware binary input (BI) indicating the space occupancy status as Occupied or Unoccupied.

d. Air Handler Occupancy Output: For a System Scheduler for a system containing an air handler, output one or more SNVTs indicating the desired occupancy status as one of the following possible values: Warm-Up-Cool-Down (when required by the AHU Sequence of Operation), Occupied and Unoccupied.

e. Terminal Unit Occupancy Output: For a System Scheduler for a stand-alone terminal unit, [a group of stand-alone terminal units acting according to a common schedule,] or a group of terminal units served by a single air handler, output one or more SNVTs indicating the desired occupancy status as one of the following possible values: Occupied and Unoccupied.

f. Default Schedule: Incorporate a 24-hour 7-day default schedule as shown on the drawings which may be activated and deactivated by the System Scheduler Logic.

g. Communication Determination: Determine the time elapsed between receipts of the scheduled occupancy input SNVT, and use this elapsed time to activate and deactivate the Default Schedule as specified. (This provides the capability for the system scheduler to use its Default Schedule if it loses communication with the UMCS).

#### 3.4.2.3 System Scheduler Output Determination

a. Air Handler Occupancy Output: If more than 95 minutes have passed since the last receipt of the Scheduled Occupancy input, the Air Handler Occupancy Output shall be determined by the default schedule and the Space Occupancy Inputs. Otherwise, the output shall be determined as follows:

(1) If the Override Occupancy Input is not OC\_NUL, the Air Handler Occupancy Output shall be determined as follows:

(a) The output shall be Occupied when the Override Occupancy Input is OC\_OCCUPIED.

(b) The output shall be Unoccupied when the Override Occupancy Input is OC\_UNOCCUPIED.

(c) If the system Sequence Of Operation specifies Warm-Up-Cool-Down mode, the output shall be Warm-Up-Cool-Down when the Override Occupancy Input is

OC\_STANDBY.

(2) If the Override Occupancy Input is OC\_NUL and the Schedule Occupancy input is OC\_OCCUPIED, the Air Handler and Stand-Alone Terminal Unit Occupancy Output shall be OC\_OCCUPIED.

(3) If the Override Occupancy Input is OC\_NUL, the Schedule Occupancy input is not OC\_OCCUPIED, and less than required number of Space Occupancy Inputs (as shown on the Occupancy Schedule Drawing) are OC\_OCCUPIED (or the hardware BI is Unoccupied), the Air Handler Occupancy Output shall be determined by the Scheduled Occupancy Input

(a) The output shall be Occupied when the Scheduled Occupancy Input is OC\_OCCUPIED.

(b) The output shall be Unoccupied when the Scheduled Occupancy Input is OC\_UNOCCUPIED.

(c) If the system Sequence Of Operation specifies Warm-Up-Cool-Down mode the output shall be Warm-Up-Cool-Down when the Scheduled Occupancy Input is OC\_STANDBY.

(4) If the Override Occupancy Input is OC\_NUL and at least the required number (as shown on the Occupancy Schedule Drawing) of Space Occupancy Inputs are OC\_OCCUPIED (or the hardware BI is Occupied), the Air Handler Occupancy Output shall be Occupied.

b. Terminal Unit Occupancy Output: If more than 95 minutes have passed since the last receipt of the Scheduled Occupancy input, the Terminal Unit Occupancy Output shall be determined by the default schedule. Otherwise, the output shall be determined as follows:

(1) If the Override Occupancy Input is not OC\_NUL, the Terminal Unit Occupancy Output shall be determined as follows:

(a) The output shall be Occupied when the Override Occupancy Input is OC\_OCCUPIED or OC\_STANDBY (to allow AHU-dependent Terminal Units to operate in Occupied mode when their associated AHU is in Warm-Up-Cool-Down.

(b) The output shall be Unoccupied when the Override Occupancy Input is OC\_UNOCCUPIED.

(2) If the Override Occupancy Input is OC\_NUL, the AHU-Dependent Terminal Unit Occupancy Output shall determined as follows:

(a) The output shall be Occupied when the Scheduled Occupancy Input is OC\_OCCUPIED or OC\_STANDBY (to allow AHU-dependent Terminal Units to operate in Occupied mode when their associated AHU is in Warm-Up-Cool-Down.

(b) The output shall be Unoccupied when the Scheduled Occupancy Input is OC\_UNOCCUPIED.

#### 3.4.2.4 Air Handler System Scheduling

a. The AHU Occupancy Output SNVT shall be bound from the System Scheduler to the DDC Hardware that executes the Occupancy Mode

#### Determination part of the Air Handler Sequence of Operation

- b. For Air Handlers using occupancy sensors, the occupancy sensor output SNVT (of type SNVT\_Occupancy) shall be bound to a Space Occupancy Input of the System Scheduler.
- c. The Terminal Unit Occupancy Output SNVT shall be bound from the System Scheduler to each AHU-Dependent Terminal Unit.
- d. AHU-Dependent Terminal Units with occupancy sensors shall have their Effective Occupancy SNVT (of type SNVT\_Occupancy) bound to a Space Occupancy Input of the System Scheduler.

#### 3.4.2.5 Stand-Alone Terminal Unit Scheduling

The Terminal Unit Occupancy Output shall be bound from the System Scheduler to the DDC Hardware that executes the Occupancy Mode Determination part of the Terminal Unit Sequence of Operation.

#### 3.4.3 Sequences of Operation for Air Handling Units

##### 3.4.3.1 Variable Air Volume System with Return Fan

Contractor shall install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs, outputs and alarms as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control shall be proportional-integral (PI) control.

##### a. HAND-OFF-AUTO switches:

Supply fan variable frequency drive (VFD) unit shall accept a Fire Alarm Panel (FAP) signal that takes precedence over all other VFD inputs and switches and shall cause the VFD to run at 100% speed. The VFD shall accept an occupant accessible emergency shutoff switch as shown. The supply fan variable frequency drive (VFD) unit shall have an integral H-O-A switch:

- (1) HAND: With the H-O-A switch in HAND position, the supply fan shall start and run continuously, subject to Safeties. Fan speed shall be under manual-operator control.
- (2) OFF: With the H-O-A switch in OFF position, the supply fan shall stop.

(3) AUTO: With the H-O-A switch in AUTO position, the supply fan shall run subject to the Supply Fan Start/Stop Signal (SF-SS) and Safeties. Fan speed shall be under control of the DDC Hardware.

[ Return fan variable frequency drive (VFD) unit shall accept a Fire Alarm Panel (FAP) signal that takes precedence over all other VFD inputs and switches and shall cause the VFD to run at 100% speed. The return fan variable frequency drive (VFD) unit shall have an integral H-O-A switch:

(1) HAND: With the H-O-A switch in HAND position, the return fan shall run subject to Safeties. Fan speed shall be under manual-operator control.

(2) OFF: With the H-O-A switch in OFF position, the return fan shall be off.

(3) AUTO: With the H-O-A switch in AUTO position, the return fan shall run subject to the supply fan running. Fan speed shall be under control of the DDC Hardware.]

b. Occupancy Modes: The system shall obtain its Occupancy Mode input from the System Scheduler as specified and shown. The system shall operate in one of the following modes: Occupied, Unoccupied[, or Warm Up/Cool Down].

c. Proofs and Safeties:

(1) The supply fan[, return fan,] and all DDC Hardware control loops shall be subject to Proofs and Safeties. Safeties shall be direct-hardwire interlocked to the VFD as shown. DDC Hardware shall monitor all proofs and safeties and failure of any proof or activation of any safety shall result in all control loops being disabled and the AHU fan being commanded off until reset.

(2) Proofs:

(a) Supply fan status (SF-S)

[(b) Return fan status (RF-S)]

(3) Safeties:

(a) Cooling coil discharge air temperature low limit (freezestat) (CLG-DA-T-LL)

(b) Supply air duct pressure high limit (SA-P-HL)

(c) Supply air smoke (SA-SMK)

(d) Return air smoke (RA-SMK)

(4) DDC Hardware reset of all proofs and safeties shall be via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

d. System Enable and Loop Enable

(1) Occupied mode: The supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS). All control loops shall be enabled. The Zone Temperature Control loops for VAV boxes serviced by the AHU shall also be enabled.

(2) Unoccupied mode: While the building temperature (BLDG-T) is above setpoint (BLDG-T-LL-SP) all control loops shall be disabled (except fan-powered VAV box Zone Temperature Control loops) and the supply fan shall not run. When BLDG-T drops below BLDG-T-LL-SP (with a 3 degreesC (5 degreesF) deadband) the supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS), the Supply Duct Static Pressure Control[, Return Fan Volume Control][, Preheat Control] loops shall be enabled. The Minimum Outside Air Flow Control, Mixed Air Temperature Control, and Cooling Coil Control loops shall be disabled.

[(3) Warm Up/Cool Down: The supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS). The Minimum Outside Air Flow Control loop shall be disabled and all other control loops shall be enabled. The Zone Temperature Control loops for VAV boxes serviced by the AHU shall also be enabled.]

e. Fan Capacity Control:

(1) Supply Duct Static Pressure Control. When this loop is enabled the DDC Hardware shall modulate the supply fan variable frequency drive unit to maintain the duct static pressure (SA-P) at setpoint (SA-P-SP) as shown, as measured by the duct static pressure tap and sensor as shown. When this loop is disabled, the DDC Hardware capacity modulation output to the VFD shall be zero percent.

[(2) Return Fan Volume Control. When this loop is enabled the DDC Hardware shall modulate the return fan variable frequency drive unit to maintain a constant volumetric airflow difference at setpoint (F-DIFF-SP) as shown, as measured by the airflow measurement arrays located in the supply and return ducts as shown. When this loop is disabled, the output to the VFD shall be zero percent.]

f. Minimum Outside Air Flow Control: When this loop is enabled the DDC Hardware shall modulate the minimum outside air damper to maintain the minimum OA volumetric flow (MINOA-F) at setpoint (MINOA-F-SP) as shown. When this loop is disabled, the minimum outside air damper shall be closed.

g. Mixed Air Temperature Control With Economizer

(1) When this loop is enabled, and the Economizer is ON as determined by the Economizer Enable Logic, the DDC Hardware shall modulate the economizer outside air, relief, and return air dampers to maintain the mixed air temperature (MA-T) at setpoint (MA-T-SP) as shown.

(2) When this loop is disabled, or the Economizer is OFF as determined by the Economizer Enable Logic, the economizer outside air and relief air dampers shall be closed, and the return air damper shall be open.

(3) Economizer Enable Logic. The economizer shall be ON when the outside air dry bulb temperature is between the high limit (ECO-HL-SP) and low limit (ECO-LL-SP) setpoints as shown. The Economizer shall otherwise be OFF. ECO-HL-SP and ECO-LL-SP shall each have a 1 degreesC (2 degreesF) deadband.

h. Cooling Coil Control: When this loop is enabled the DDC Hardware shall modulate the cooling coil valve to maintain the supply air temperature (SA-T) setpoint (SA-T-SP) as shown. When this loop is disabled, the cooling coil valve shall be closed.

[i. Preheat Coil Control: When this loop is enabled the DDC Hardware shall modulate the preheat coil valve to maintain the preheat coil discharge air temperature (PH-DA-T) at setpoint (PH-DA-T-SP) as shown. When this loop is disabled, the preheat coil valve shall be closed.]

#### 3.4.4 Sequences of Operation for Terminal Units

##### 3.4.4.1 Zone Temperature Control - Cooling-Only VAV Box

Contractor shall install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs, outputs and alarms as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control shall be proportional-integral (PI) control.

##### a. Occupancy Modes:

(1) Occupied: The VAV box DDC Hardware shall be in the Occupied Mode when the local space occupancy input(s) (ZN-OCC) indicate that the space is occupied or when the input from the System Scheduler (SYS-OCC) is occupied.

(2) Unoccupied: The VAV box DDC Hardware shall be in the Unoccupied Mode when the local space occupancy input(s) (ZN-OCC) indicate that the space is unoccupied and the input from the System Scheduler (SYS-OCC) is unoccupied.

##### b. Safeties: This system has no safeties.

##### c. Zone Temperature Control

(1) In the Occupied Mode the zone temperature setpoint (ZN-T-SP) shall be at the configured setpoint or at the occupant-adjustable setpoint via the wall-mounted thermostat, as shown. The DDC Hardware shall modulate the VAV box damper to maintain VAV box supply air flow (VAV-SA-F) at setpoint as measured by a multi-point flow sensing element at the inlet to the VAV box. Sequencing shall be as shown: Upon a rise in zone temperature (ZN-T) above zone setpoint (ZN-T-SP), subject to the zone temperature setpoint deadband as shown, the airflow setpoint shall be adjusted between minimum and maximum flow based on the difference between zone temperature and zone temperature setpoint as shown.

(2) In the Unoccupied Mode the VAV box damper shall be at its minimum position.

## 3.4.4.2 Zone Temperature Control - VAV Box with Reheat

Contractor shall install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs, outputs and alarms as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control shall be proportional-integral (PI) control.

## a. Occupancy Modes:

(1) Occupied: The VAV box DDC Hardware shall be in the Occupied Mode when the local space occupancy input(s) (ZN-OCC) indicate that the space is occupied or when the input from the System Scheduler (SYS-OCC) is occupied.

(2) Unoccupied: The VAV box DDC Hardware shall be in the Unoccupied Mode when the local space occupancy input(s) (ZN-OCC) indicate that the space is unoccupied and the input from the System Scheduler (SYS-OCC) is unoccupied.

b. Safeties: VAV boxes with electric resistance heating elements shall require proof of air flow before activating the heating elements.

## c. Zone Temperature Control:

(1) In the Occupied Mode the zone temperature setpoint (ZN-T-SP) shall be at the configured setpoint or at the occupant-adjustable setpoint via the wall-mounted thermostat, as shown.

(2) In the Unoccupied Mode the zone temperature setpoint (ZN-T-SP) shall be at the configured setpoint as shown.

(3) The DDC Hardware shall modulate the VAV box damper to maintain VAV box supply air flow (VAV-SA-F) at setpoint as measured by a multi-point flow sensing element at the inlet to the VAV box. Sequencing shall be as shown: Upon a rise in zone temperature above zone temperature setpoint (ZN-T-SP), subject to the zone temperature setpoint deadband as shown, the airflow setpoint shall be adjusted between minimum and maximum flow based on the difference between zone temperature and zone temperature setpoint as shown. Upon a fall in zone temperature below zone temperature setpoint, subject to the deadband as shown, the airflow shall be maintained at a fixed air flow setpoint (with a setting independent of the cooling minimum air flow), and the heating valve shall modulate towards open or the staged electric resistance heating coil(s) shall cycle on in sequence.

### 3.4.5 Sequences of Operation for Hydronic Systems

#### 3.4.5.1 Hydronic Heating Hot Water From Single-Building Boiler

Contractor shall install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs, outputs and alarms as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control shall be proportional-integral (PI) control.

a. System Enable and loop enable

(1) This system shall monitor the enabled status of all systems served by this system. If one or more systems served by this system are enabled, this system shall be enabled (SYS-ENA). If all systems served by this system are not enabled, this system shall not be enabled.

(2) When this system is enabled (SYS-ENA) and the hot water pump is proofed on, the boiler control and hot water temperature control loops shall be enabled.

b. HAND-OFF-AUTO Switch: The hot water pump motor starter shall have an H-O-A switch:

(1) HAND: With the H-O-A switch in HAND position, the pump shall start and run continuously.

(2) OFF: With the H-O-A switch in OFF position, the pump shall stop.

(3) AUTO: With the H-O-A switch in AUTO position, the pump shall run subject to the Hot Water Pump Start/Stop (HW-PMP-SS) command.

c. Proofs and Safeties:

(1) DDC Hardware shall monitor all proofs and safeties.

(2) Proofs: Hot water pump

(3) Safeties: None

(4) DDC Hardware reset of all proofs and safeties shall be via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

d. Boiler Control: When this loop is enabled, the DDC Hardware shall turn the boiler on. When this loop is disabled, the boiler shall be off.

e. Hot Water Temperature Control: When this loop is enabled the DDC Hardware shall modulate the 3-way mixing valve to maintain hot water supply temperature (HWS-T) at setpoint (HWS-T-SP). The Hot Water Supply Temperature Setpoint (HWS-T-SP) shall be [determined from a linear reset schedule] as shown. When this loop is disabled, the valve shall be in its normal (failsafe) position.

### 3.5 CONTROLLER TUNING

The Contractor shall tune each controller in a manner consistent with that described in the ASHRAE Fundamentals Hdbk. Tuning shall consist of adjustment of the proportional, integral, and where applicable, the derivative (PID) settings to provide stable closed-loop control. Each loop shall be tuned while the system or plant is operating at a high gain (worst case) condition, where high gain can generally be defined as a low-flow or low-load condition. Upon final adjustment of the PID settings, in response to a change in controller setpoint, the controlled variable shall settle out at the new setpoint with no more than two (2) oscillations above and below setpoint. Upon settling out at the new setpoint the controller output shall be steady. With the exception of naturally slow processes such as zone temperature control, the controller shall settle out at the new setpoint within five (5) minutes. The Contractor shall return the controller to its original setpoint and shall record and submit the final PID configuration settings with the O&M Instructions and on the associated Points Schedule.

### 3.6 START-UP AND START-UP TEST

The Contractor shall perform the following startup tests for each control system to ensure that the described control system components are installed and functioning per this specification.

a. General: The Contractor shall adjust, calibrate, measure, program, configure, set the time schedules, set alarms, and otherwise perform all necessary actions to ensure that the systems function as specified and shown in the sequence of operation and other contract documents.

b. Systems Check: An item-by-item check shall be performed for each HVAC system;

(1) Step 1 - System Inspection: With the system shut down, it shall be verified that power and main air are available where required and that all output devices are in their failsafe and normal positions. Each local display panel [and each M&C Client] shall be inspected to verify that all displays indicate shutdown conditions.

(2) Step 2 - Calibration Accuracy Check: A two-point accuracy check of the calibration of each HVAC control system sensing element and transmitter shall be performed by comparing the SNVT output from the DDC Hardware the sensor is connected to the actual value of the variable measured at the sensing element. Digital indicating test instruments shall be used, such as digital thermometers, motor-driven psychrometers, and tachometers. The test instruments shall be at least twice as accurate as the specified sensor accuracy. The calibration of the test instruments shall be traceable to National Institute Of Standards And Technology standards. The first check point shall be with the HVAC system in the shutdown condition, and the second check point shall be with the HVAC system in an operational condition.

Calibration checks shall verify that the sensing element-to-DDC system readout accuracies at two points are within the specified product accuracy tolerances. If not, the device shall be recalibrated or replaced and the calibration check repeated.

(3) Step 3 - Actuator Range Check: With the system running, a signal shall be applied to each actuator through the DDC Hardware controller. Proper operation of the actuators and positioners for all actuated devices shall be verified and the signal levels shall be recorded for the extreme positions of each device. The signal shall be varied from live zero to full range, and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. Where applicable, it shall be verified that all sequenced actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.

c. Weather Dependent Test: Weather dependent test procedures that cannot be performed by simulation shall be performed in the appropriate climatic season. When simulation is used, the actual results shall be verified in the appropriate season.

Test Report: Upon completion of the Start-Up Test, the Contractor shall prepare and submit a Start-Up and Start-Up Testing Report documenting the results of the tests performed and certifying that the system is installed and functioning per this specification, and is ready for the Performance Verification Test (PVT).

### 3.7 PERFORMANCE VERIFICATION TEST (PVT)

#### 3.7.1 PVT Procedures

The performance verification test procedures shall explain, step-by-step, the actions and expected results that will demonstrate that the control system performs in accordance with the sequences of operation, and other contract documents. [The PVT shall include a one-point accuracy check of each sensor. ] [The PVT shall include inlet and outlet air temperature measurements for all AHU-dependent terminal units. ] The PVT Procedure shall describe a methodology to measure and trend the network bandwidth usage on the network backbone and compare it to the Bandwidth Usage Calculation submittal. A control system performance verification test equipment list shall be included that lists the equipment to be used during performance verification testing. The list shall include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration.

#### 3.7.2 PVT Execution

The Contractor shall demonstrate compliance of the control system with the contract documents. Using test plans and procedures approved by the Government, the Contractor shall demonstrate all physical and functional requirements of the project. The performance verification test shall show, step-by-step, the actions and results demonstrating that the control systems perform in accordance with the sequences of operation. The performance verification test shall measure and trend the Network Bandwidth Usage and compare it to the Bandwidth Usage Calculation submittal. The performance verification test shall not be started until after receipt by the Contractor of written permission by the Government, based on Government approval of the Start-Up and Start-Up Testing Report and completion of

balancing. The tests shall not be conducted during scheduled seasonal off periods of base heating and cooling systems.

### 3.7.3 PVT Report

Contractor shall prepare a PVT report documenting all tests performed during the PVT and their results. The PVT report shall include all tests in the PVT Procedures and any other testing performed during the PVT. Failures and repairs shall be documented with test results.

## 3.8 TRAINING

A training course shall be conducted for [\_\_\_] operating staff members designated by the Government in the maintenance and operation of the system, including specified hardware and software. The training period, for a total of [32] [\_\_\_] hours of normal working time, shall be conducted within 30 days after successful completion of the performance verification test. The training course shall be conducted at the project site and the Government reserves the right to videotape the training sessions for later use. Audiovisual equipment and [\_\_\_] sets of all other training materials and supplies shall be provided. A training day is defined as 8 hours of classroom instruction, including two 15 minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility.

### 3.8.1 Training Documentation

The Contractor shall prepare training documentation consisting of:

- a. Course Attendee List: A List of course attendees which shall be developed in coordination with and signed by the [Controls] [HVAC] [Electrical] shop supervisor.
- b. Training Manuals: Training manuals shall include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson. Where the Contractor presents portions of the course material by audiovisuals, copies of those audiovisuals shall be delivered to the Government as a part of the printed training manuals. Training manuals shall be delivered for each trainee with two additional copies delivered for archival at the project site.

### 3.8.2 Training Course Content

For guidance in planning the required instruction, the Contractor shall assume that attendees will have a high school education or equivalent, and are familiar with HVAC systems. The training course shall cover all of the material contained in the Operating and Maintenance Instructions, the layout and location of each controller enclosure, the layout of one of each type of unitary equipment and the locations of each, the location of each control device external to the panels, the location of the compressed air station, preventive maintenance, troubleshooting, diagnostics, calibration, adjustment, commissioning, tuning, repair procedures, use of LNS Plug-ins, and use of the GPPC Programming software. Typical systems and similar systems may be treated as a group, with instruction on the physical layout of one such system. The results of the performance verification test and the Start-Up and Start-Up Testing Report shall be presented as benchmarks of HVAC control system performance by which to measure operation and

maintenance effectiveness.

## APPENDIX A

QC CHECKLIST

This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such.

This checklist is for (check one:)

Pre-Construction QC Checklist Submittal (Items 1-5) |\_\_\_\_|

Post-Construction QC Checklist Submittal (Items 1-12) |\_\_\_\_|

Close-out QC Checklist Submittal (Items 1-19) |\_\_\_\_|

Initial each item in the space provided (|\_\_\_\_|) verifying that requirement has been met.

Items verified for Pre-Construction, Post-Construction and Closeout QC Checklists Submittal:

- 1 Network bandwidth calculations have been performed, and the backbone type (Ethernet or TP/FT-10) has been determined based on these calculations. |\_\_\_\_|
- 2 All DDC Hardware (nodes) are numbered on Control System Schematic Drawings. |\_\_\_\_|
- 3 Signal lines on Control System Schematic are labeled with the signal type. |\_\_\_\_|
- 4 Local Display Panel (LDP) Locations are shown on Control System Schematic drawings. |\_\_\_\_|
- 5 Points Schedule drawings have been sub-divided by device (DDC Hardware), including DDC Hardware node numbers. |\_\_\_\_|

Items verified for Post-Construction and Closeout QC Checklist Submittal:

- 6 All DDC Hardware is installed on a TP/FT-10 local control bus. |\_\_\_\_|
- 7 All Application Specific Controllers (ASCs) are LonMark certified. |\_\_\_\_|
- 8 Communication between DDC Hardware is only via ANSI/EIA 709.1B using SNVTs. Other protocols and network variables other than SNVTs have not been used. |\_\_\_\_|
- 9 Explicit messaging has not been used. |\_\_\_\_|
- 10 System Scheduler functionality has been installed for all HVAC systems and default schedules have been configured at each System Scheduler. |\_\_\_\_|
- 11 All sequences are performed as specified using DDC Hardware. |\_\_\_\_|
- 12 Training schedule and course attendee list has been |\_\_\_\_|

QC CHECKLIST

developed and coordinated with shops and submitted.

Items verified for Closeout QC Checklists Submittal:

- |    |  |      |
|----|--|------|
| 13 | Final As-built Drawings, including the Points Schedule drawings accurately represent the final installed system. | ____ |
| 14 | LonWorks Network Services (LNS) Database is up-to-date and accurately represents the final installed system.     | ____ |
| 15 | LNS Plug-ins have been submitted for all ASCs.   | ____ |
| 16 | Programming software has been submitted for all General Purpose Programmable Controllers (GPPCs).                | ____ |
| 17 | All software has been licensed to the Government   | ____ |
| 18 | O&M Instructions have been completed and submitted.  | ____ |
| 19 | Training course has been completed.  | ____ |

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(QC Representative Signature)

(Date)

-- End of Section --